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History and Theory

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Abstract

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RACHEL CLARKE is a new media artist, writer and Professor at California State University, Sacramento. Combining physical and virtual modes of making, her work intertwines themes of nature, culture and technology, incorporating augmented/virtual reality and experimental 3D. Her work has been shown in galleries, museums, new media art festivals and film screenings nationally and internationally. rachelclarke.net

# Front matter

## Title Pages

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## Preface

The *Bloomsbury* *Encyclopedia of New Media Art* provides scholars, students and practitioners with the first comprehensive and systematic overview of new media art around the world.

New media art is a global cultural phenomenon. In addition to venues and collections in the Global North and Asia, venues, festivals, exhibitions, biennials and triennials in Latin America, Australia, Africa and Asia-Pacific have facilitated a growing transcultural exchange of ideas. Diaspora and migration, political change, education, travel, mass communication and the development of economies in the Global South have expanded awareness and opportunity. Women, LGBTQ+ and BIPOC artists have also created space for new explorations and contributions – artists of all gender identities, ethnicities and global regions are now shaping the field.

This global expansion of new media art reveals an incredible wealth of cultural perspectives, new practices and discourses. By definition, new media is an art of change, and many artists, historians, theorists and curators in countries undergoing significant economic, political and cultural shifts have been and are drawn to the medium as a vehicle of expression and critique. In examining the origins and evolution of media practices as well as their institutional and cultural contexts, the Encyclopedia reveals new media art as the quintessential art form of our digital age.

Traditionally, the value of an artwork has resided in its uniqueness. What (or where) is the value of an art form which relinquishes uniqueness in exchange for becoming ephemeral, reproducible, processual or distributed? How can an art form be defined and judged if it combines text, images, video and sound; or uses code and social relations as its medium; or eschews the model of artist-creator for participatory art and user-generated content? These questions are central to the Encyclopedia’s critical engagement with both theory and practice, and with the complexities, contradictions and ambiguities inherent in new media art. Covering history, theory, practice, technologies, social contexts and curation, the Encyclopedia rigorously questions what (if anything) makes new media art “new”.

Our aim in producing this Encyclopedia is to enable artists to better evaluate the motivations and interactions that inform practice; and to present historians, theorists, curators and critics with a fuller picture of new media art’s response to the challenges of the global digital age.

## Editors-in Chief

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## Volume Introduction

“New media art” was one of the many names given to a variety of art practices usually, though not always, involving forms of electronic and digital technologies. Others include computer art, electronic art, digital art and so on. The question of nomenclature has been one of the major issues discussed among theorists and practitioners over decades of debate. In the end the name used does not particularly matter, as long as one concedes that it will be unsatisfactory, and will have to stand for an ill-defined and inadequately delimited array of practices and ideas. For us new media art is less an area of art defined by the use of technologies and media/mediums than the name given for a way of thinking about the world as it is massively changed by technological developments.

From the vantage point of the third decade of the twenty-first century it is obvious that developments such as the World Wide Web and the smart phone are having incalculable and unprecedented effects on every aspect of our lives. Yet, only thirty years ago, when I undertook a master’s degree in computing in art, most people did not regard technologies such as the computer as having much relevance to their lives, and certainly as having no connection to art. Of course by then there had been decades of art made using such technologies, but such was the resistance to technology shown by those in the arts and humanities, this work might as well not have existed as far as museums, galleries and art-history departments were concerned. When Paul Brown, Nick Lambert, Catherine Mason and I started the AHRB-funded CACHe (Computer Art Context History etc.) project at Birkbeck College, London, looking at early British computer art, we found extraordinary hidden riches, pioneering work done since the 1950s, completely ignored by cultural gatekeepers such as Tate.

The point here is not to criticize Tate or other such organizations, but rather to show how their inability to encompass this work is symptomatic of the profound changes to which such work was responding. Those changes would eventually transform our very understanding of art beyond the imaginative capacity of the art world at the time of the early pioneers. It’s only with the emergence of the World Wide Web in the 1990s that it became clear to some people at least that everything was changing.

### Life on Mars

There is a funny and telling exchange available on YouTube in a BBC interview on *Newsnight* between Jeremy Paxman, a TV presenter, and David Bowie, from 1999 ([BBC Newsnight 1999](#b-9781474207935-032-0000075)). Paxman is almost parodically Oxbridge and seemingly unable to grasp the implications of the WWW. In the interview Bowie suggests that up to the mid-1970s we were still living in a “single and absolute created society” in which there were “known truths and known lies and no kind of duplicity or pluralism about the things that we believed in”. According to Bowie, this started to break down in the 1970s, with “the idea of a duality in the way we live” in which “there are two, three, four, five sides to every question”. The “singularity disappeared” producing a medium such as the internet, which means we are living in “total fragmentation”. In Bowie’s words, “I think the potential of what the internet is going to do to society—both good and bad—is unimaginable. I think we’re actually on the cusp of something exhilarating and terrifying”. Paxman replied saying, “It’s just a tool, though, isn’t it?” “No it’s not”, stated Bowie. “It’s an alien life form. Is there life on Mars? Yes, it’s just landed here”.

Bowie’s prescience is rightly recognized, but new media artists had been predicting our present since before the 1970s. For example, Kit Galloway and Sherrie Rabinowitz’ work *Hole-in-Space* (1980) used a live TV feed to connect New York and Los Angeles, to enable people able to talk to each other on the other side of the continent—prefiguring the world of instantaneous visual communication made possible by Skype, Zoom, Teams and other such programs. It was also in the year 1980 that Jacques Derrida published *La carte postale*, which foregrounded the philosophical implications of telecommunications ([Derrida and Bass 1980](#b-9781474207935-032-0000089)). Thus, new media artists are the proper avant-garde of emerging techno-social developments, or, as in the idea often attributed to Marshall McLuhan, of art as the advance warning system for culture.

### The First New Media

The question is when do we see the first new media? Is it the introduction of print, originally developed in China, in the West, ushering in what McLuhan calls the “Gutenberg Galaxy” (1962)? Is it that moment in the 1820s and 1830s when photography, telegraphy and even computing (in the form of Charles Babbage’s Difference and Analytical Engines) were all developed? Is it the increasingly mechanized mass production and circulation of books, newspapers and magazines in the nineteenth century? Is it towards the end of the same century, firstly with the gramophone and the typewriter and then with cinema and radio? Or a couple of decades later with television? Or do we have to date new media properly with the first electronic digital binary computers built at the end of and after the Second World War? Or even with the emergence of the idea of “telematics” in the late 1970s? Each one of these developments has had a definite cultural effect, and in the case of, for example, photography, helped to profoundly change painting.

It is perhaps less a question of which technologies make new media art possible and more what is meant by the use of the words “media” or “medium”. It may seem obvious to us that a work of art of any sense is a medium through which something, an idea perhaps, is, for want of a better word, transmitted, much as a television is a medium through which a televisual signal is transmitted. But the idea of art as a medium is perhaps less universal than we might think. One possible date for its emergence is the second half of the nineteenth century, in particular the 1870s. Thomas Edison invented, or at least patented, the phonograph in 1877. There were some earlier sound recording and playing devices, but Edison’s invention is the first significant machine of that sort. Four years earlier, in 1873, the art theorist and critic Walter Pater published his book *Studies in the History of the Renaissance*. Though under-appreciated, Pater is now probably one of the most important figures in nineteenth-century art, especially in relation to the rise of what became known as Aestheticism. Indeed, *The Renaissance* could be thought of as the founding text of Aestheticism.

In *The Renaissance* Pater declared the need to “see the object as in itself it really is”, which is really “to know one’s own impression as it really is, to discriminate it, to realise it distinctly”. Therefore, “he who experiences these impressions strongly, and drives directly at the discrimination and analysis of them, has no need to trouble himself with the abstract question of what beauty is in itself, or what its exact relation to truth or experience is—metaphysical questions, as unprofitable as metaphysical questions elsewhere” ([1873](#b-9781474207935-032-0000142): viii). Pater considered the brief, ephemeral sensation to be the most important experience in life, such as “a sudden light transfigures some trivial thing, a weather-vane, a wind-mill, a winnowing fan, the dust in the barn door. A moment—and the thing has vanished, because it was pure effect; but it leaves a relish behind it, a longing that the accident may happen again”. As he put it, “To burn always with this hard, gemlike flame, to maintain this ecstasy, is success in life”. He famously declared what was clearly his manifesto for a life of pure sensation: that “all art constantly aspires towards the condition of music” (ibid.: 140).

Even though the Aestheticism he fostered was a reaction against new media such as photography, in a sense, Pater is also the first media theorist *avant la lettre*. As Sean Cubitt points out, in Pater’s idea that all art aspires to the condition of music we find the beginnings of our modern understanding of how we engage with media. Cubitt suggests that “Pater was of the first generation to shut their eyes during a performance, since it is the purity of music, its distance from denotative meanings, its abstraction, to which the other media … aspired” ([1991](#b-9781474207935-032-0000083): 44). Thus, the “purity of sound had to be conceptualised before it could be invented as technology” (ibid.). For Cubitt, therefore:

The ‘purity’ of music is the condition of its becoming a commodity: before it can be exchanged and consumed under the aegis of capital, music must first be divorced from the moment of its production. The labour of performance has to be subsumed into the autonomous status of an object before it can be understood as product, standing free of the material practice of its production, both steps essential to its circulation as commodity, organised into the forms of communication and profit-making which the social formation of capital demands.

— (ibid.)

### The Poem That made us Modern

Among those who strove to realize Pater’s idea of all art aspiring to the condition of music was Stéphane Mallarmé, who radically redefined poetry, and offered a new vision of the world as it was coming to be in the late nineteenth century. I would suggest that the beginnings of new media art can, perhaps, be traced back to the first publication in 1897 of Mallarmé’s radically innovative poem *Un coup de dés jamais n’abolira le hasard*. The poem takes the form of twenty pages of text, with words strewn across the pages in an apparently chaotic manner. Mallarmé was taking the possibilities of *vers libre*, free verse, meaning poetry liberated from metrical and rhythmic constraints, to their greatest possible extent.

The poem brings our attention to its medium and materiality, its typography, its use of the white space of the page. As Jacques Derrida puts it, the “labor of writing is no long transparent ether. It catches our attention and forces us, since we are unable to go beyond it with a simple gesture of what it ‘means’, to stop short in front of it or work with it” ([Derrida and Attridge 1992](#b-9781474207935-032-0000086): 114). For some Mallarmé’s poem quite literally “made us modern”, as R. Howard Bloch puts it, in that it anticipated new understandings of time and space that would emerge in the twentieth century ([Bloch 2016](#b-9781474207935-032-0000077)). Its influence went far beyond poetry, and had a profound effect on music and the visual arts throughout the next hundred years or more. Critics such as Edmund Wilson ([1931](#b-9781474207935-032-0000156): 295) compared Mallarmé to Einstein, while Jean Hyppolite (1960) and Jeffrey [Mehlman (1980)](#b-9781474207935-032-0000134) saw his work as prefiguring Norbert Wiener’s cybernetics. Among Mallarmé’s key ideas was that the world is “fiction”, and that everything exists to be put in a book. He dreamt of what he called *Le livre*, the Book, an unrealized and indeed unrealizable project to write a total artwork in the form of a book that includes all books. Mallarmé’s little essay or “divigation”, “Etalages” (Displays), looks at the state of writing and contrasts the commodification of the book with the “reseau de communications”, the “network of communication” by which poetry circulates discretely ([Mallarmé and Johnson 2009](#b-9781474207935-032-0000128): 225). Writing in response to the celebrations of his legacy at the centenary of his death Rosemary Lloyd suggested that “Mallarmé’s evocation, in his study entitled ‘*Etalages*’, of a ‘reseau de communications’ may not have included the world-wide web, but he would certainly have enjoyed finding himself transformed and represented in electronic media, and may well have reformulated Un coup de dés into something more digital” ([2000](#b-9781474207935-032-0000118)). Nicolas Lubecker points out that, given

the looped structure of the poem (it begins and ends with the same four words) and its mathematical, cosmic and metaphysical nature, it is unsurprising that it has been picked up by cybernetics-inspired readers. The overall ideas about the self-perfecting machine, the feedback loop and the poem as a place where cognitive, ontological and existential dimensions gradually align all pull the poem in the direction of cybernetics.

— ([2020](#b-9781474207935-032-0000123): 153)

In his book *The Number and the Siren* philosopher Quentin Meillassoux performs a highly rigorous and methodical analysis of the poem and of the circumstances of its genesis, in order to arrive at what he claims is “the number” that is at the heart of the poem, the “unique number that cannot be another”, produced by the throw of the dice by the “Master”. Thus he discovers that “the number” is 707, the number of words in the poem, minus the last seven, which he understands as a kind of motto to the rest of the poem. Meillassoux cites some of Mallarmé’s earlier poems, which comprise 70 and 77 words respectively, and every version of *Un coup de dés jamais n’abolira le hasard*, whatever the textual variations, kept to the number of 707 words. This is the number that is produced by the poem, and by implication means that the dice that the “Master”, within the poem, is unable to decide whether to throw or not are actually thrown, because order is, in the end, found in the flux. Seven, in Mallarmé’s poetico-numerological mythology, is highly significant, and represents a high degree of order, and Meillassoux believes he has found this figure in the poem. Zero negates that order, but the second seven negates the negation. Thus, in effect, the throw of the dice both negates the order of traditional poetics, but also negates the negation, and produces order in the midst of the flux of contingency ([Meillassoux, Mackay and Mallarmé 2012](#b-9781474207935-032-0000139)).

### The Second Bomb

Mallarmé’s flux of contingency has, perhaps, been realized in Bowie’s vision of the internet as the medium of total fragmentation as he put it in his interview with Jeremy Paxman. If this is the case then art using new media may be the way in which order can be brought to that flux. The best reason for emphasizing Mallarmé’s prescience in terms of new media art is how *Un coup de dés jamais n’abolira le hasard* offers us a diagram of the flux and chaos of such art, as it develops over the twentieth and twenty-first centuries. In particular his work, with its abstraction, spatialization and atomization of the word, seemed to prefigure the changes wrought by the technical developments in the middle of the last century that enabled the dawn of the nuclear epoch and the invention of the modern digital, binary computer. For Jacques Derrida that epoch is “dealt with more ‘seriously’ in the writings of Mallarmé, of Kafka, or Joyce, for example, than in present-day novels that would describe a ‘true’ nuclear catastrophe directly and in a ‘realistic’ fashion” ([Derrida, Kamuf and Rottenberg 2007](#b-9781474207935-032-0000092): 402). Derrida writes of the “extraordinary sophistication of its technologies—which are also the technologies of delivery, sending, dispatching, of the missile in general, of mission, missive, emission, and transmission” (ibid.: 395). The connection between nuclear weaponry and computing is found in Albert Einstein’s idea of the three bombs, described by Paul Virilio in a discussion with Friedrich Kittler in 1992.

My impression is that what is being bandied about as the progress of communication is in fact merely a step backward, an unbelievable archaism. To reduce the world to one unique time, to one unique situation, because it has exhausted the possibility to devise new systems of acceleration, is an accident without precedent, a historical accident the like of which has never occurred before. Indeed, this is what Einstein called, very judiciously, ‘the second bomb’. The first bomb was the atomic bomb, the second one is the information bomb, that is, the bomb that throws us into ‘real time.’ I believe that what people say about the performance of computing also applies to the faculty of looking at the world, to the faculty of shaping the world, of steering it, but also of living in it.

— ([Virilio, Kittler and Armitage 1999](#b-9781474207935-032-0000151): 83)

### Self-Replicating Machine

If art is, to use McLuhan’s comparison, an “early warning system” to prepare us for cultural change, then new media art is that form of art that helps us understand what the new media are doing to us, even with such fundamental aspects of our existence as language and meaning. Boris Groys sees Google as “playing the role that was traditionally filled by philosophy and religion”, particularly in how it “regulates our dialogue with the world by substituting ‘vague’ metaphysical and ideological presuppositions with strictly formalized and universally applicable rules of access” ([2012](#b-9781474207935-032-0000105): 6). It does this by dissolving all discourses by “turning them into the word clouds that function as collections of words beyond grammar” (ibid.: 7). Thus Google “is based on a belief in extragrammatical freedom of all words and their right to migrate freely—from one local, particular word cloud to another” (ibid.). This means that grammar “has lost its grammatical power over words”, as it is the means by which a hierarchy is created among words. Groys traces the liberation of words from grammar from Plato through to Roman Jakobson and Ferdinand de Saussure and onto Derridean deconstruction (ibid.: 7–9).

Here, individual words began to migrate from one context to another, permanently changing their meanings on the way. Accordingly, any attempt to establish a normative context was declared futile. But this migration was understood by deconstruction as a potentially infinite migration with an infinite trajectory, so that every question that concerned the meaning of words was declared to be unanswerable.

— (ibid.: 8–9)

For Groys Google “turns deconstruction from its head onto its feet by substituting a potentially infinite but only imaginary proliferation of contexts with a finite search engine” (ibid.: 9). Against Heidegger’s vision of language as the house of being, in which man dwells, and is the shepherd of words, we have become curators of word clouds, in which “words appear or disappear in different context—in a completely silent, purely operational, extra- or meta-linguistic mode of practice” (ibid.: 11). Groys suggests that this had been predicted by the Futurist and Fascist Tommaso Marinetti in his text on the “destruction of syntax” in which he declared the notion of *parole in libertà* (words in liberty), liberating writing from grammar and syntax. He also finds it in Freudian uses of language, Surrealist art and literature, and conceptual art of the 1960s and 1970s. Surprisingly perhaps he does not mention Mallarmé and his spatialization of language (ibid.: 12–13).

Mallarmé’s poem has not just influenced almost every generation of artists or writers since the beginning of the twentieth century but has spawned a sizable number of adaptations, tributes, versions and détournements—from Marcel Broodthaers’ famous version from 1969 in which the lines of texts are substituted with solid blocks, through to numerous book projects, videos and works which exploit the digital potential of the poem. One such digital version stands out as showing the prescience of *Un coup de dés jamais n’abolira le hasard*. In 2015 Karen ann Donnachie and Andy Simionato launched the internet artwork [<www.athrowofthedicewillneverabolishchance.com>](www.athrowofthedicewillneverabolishchance.com). Donnachie and Simionato decided to reimagine the poem as a “self-replicating machine—the primary function of which is to generate ulterior machines—by developing a *techne* for self-generative literary production using Google’s own attempts to find meaning in the book” ([2018](#b-9781474207935-032-0000095): 41). They were unsatisfied with early experiments, until they found an “unexpected co-author: Google corporation” (ibid.: 44). The “machinery” they used to “form a meeting point between Mallarmé’s original poem (written in 1897) and the uber-book of Google (registered in 1997)” was Google’s reCAPTCHA service (ibid.: 45). This is a version of the CAPTCHA software with which most web users will be familiar. Standing for “Completely Automated Public Turing test to tell Computers and Humans Apart”, it is what generates the test that asks the user to type distorted letters and numbers in a box before gaining entry to websites. ReCAPTCHA was developed in 2009 to help with Google’s project of digitizing every book in the world. Whenever the Optical Character Recognition (OCR) system used for that digitization fails to recognize a piece of text, perhaps because it is distorted or blurred, a human reader is enlisted to do so. One of the most important aspects of this is that Google’s massive project is not primarily designed for humans to be able to read the book, but for AI to do so. Donnachie and Simionato suggest that Google are taking Mallarmé’s statement that everything exists to end up in a book “a step further” (ibid.: 46). The algorithm behind [<www.athrowofthedicewillneverabolishchance.com>](www.athrowofthedicewillneverabolishchance.com) generates “a unique, randomized combination of reCAPTCHAs arranged with the same spatial distribution as Mallarmé’s ‘Un coup de dés jamais n’abolira le hasard’, therefore each access to the page potentially generates a new edition of the book” (ibid.). Furthermore the “reader is encouraged to save and resubmit their new edition of A Throw of the Dice to be catalogued in the Google book project” with the result that

Predictably, Google’s OCR system will continue to fail to read the texts made up of the same reCAPTCHAs it previously could not decipher, and once again, the Google project will enlist the help of other human readers to resolve these undecipherable images of words. In this way, A Throw of the Dice becomes a recombinatorial, recursive, self-productive machine capable of making and unmaking meaning across Mallarmé’s cryptic ‘unfinal’ book of poetry and Google’s book project, each meeting points of the book a century apart.

— (ibid.: 46–7)

Donnachie and Simionato finish their paper describing the project with what now looks like an optimistic view of the use of AI by Google:

The algorithms of AI are coded to learn through our actions, see through our eyes, gathering data on every click, post, like or other traces we leave as we move through electronic space. Despite the increasingly large sets of semantic and visual data processed and incorporated into databases and used for machine-learning by existing AI, it currently continues to struggle to comprehend human expression, behaviour or language. Our *A Throw of the Dice*, deliberately designed to be unresolvable by existing AI, remains as ‘unfinal’ as Mallarmé’s original poem, every new recombination makes and unmakes new meanings, such that the AI that attempts to read it must necessarily return, in a tireless techno-metaphysical search for truth. In short, *A Throw of the Dice*, is poetry for robots.

— (ibid.: 48)

### The End of Media

Since 2018, when the paper was published, AI has apparently advanced considerably. In 2022 Google engineer Blake Lemoine was fired for suggesting that LaMDA (Language Model for Dialogue Applications), the company’s AI chatbot, was conscious. In 2023 a slew of AI researchers, including Sam Altman of OpenAI ([Gairola 2023](#b-9781474207935-032-0000100)), and Geoffrey Hinton ([Taylor and Hern 2023](#b-9781474207935-032-0000148)) warned that AI could destroy humanity ([Chowdhury 2023](#b-9781474207935-032-0000080)). The success of programs such as ChatGPT also led to moral panics about job redundancies, student teaching and other predictable anxieties. What AI does, perhaps, threaten is the very idea of media itself, especially if the human element in any circuit of communication is increasingly unnecessary. Back in the 1990s Friedrich Kittler warned that

Before the end, something is coming to an end. The general digitisation of channels and information erases the differences among individual media. Sound and image, voice and text are reduced to surface effects, known to consumers as interface. Sense and the senses turn into eyewash. Their media-produced glamour will survive for an interim as a by-product of strategic programs. Inside the computers themselves everything becomes a number: quantity without image, sound, or voice. And once optical fiber networks turn formerly distinct data flows into a standardized series of digitized numbers, any medium can be translated into any other. With numbers, everything goes. Modulation, transformation, synchronization: delay, storage, transposition; scrambling, scanning, mapping – a total media link on a digital base will erase the very concept of medium. Instead of wiring people and technologies, absolute knowledge will run as an absolute loop.

— ([1999](#b-9781474207935-032-0000145): 1–2)

Similarly Bernhard Siegert suggests that

The impossibility of technologically processing data in real time is the possibility of art. … As long as processing in real time was not available, data always had to be stored intermediately somewhere – on skin, wax, clay, stone, papyrus, linen, paper, wood, or on the cerebral cortex – in order to be transmitted or otherwise processed. It was precisely in this way that data became something palpable for human beings, that it opened up the field of art. Conversely it is nonsensical to speak of the availability of real-time processing … insofar as the concept of availability implies the human being as subject. After all, real-time processing is the exact opposite of being available. It is not available to the feedback loops of the human senses, but instead to the standards of signal processors, since real-time processing is defined precisely as the evasion of the senses.

— ([1999](#b-9781474207935-032-0000145): 12)

Kittler’s and Siegert’s words now seem prescient, given the rise of AI systems such as ChatGPT. According to Maggie Harrison at the Futurism website:

scientists at Rice and Stanford University found that feeding AI-generated content to AI models seems to cause their output quality to erode. Train generative AI models – large language models and image generators both included – enough AI-spun stuff, it seems, and this ouroboros-like self-consumption will break the model’s digital brain.

— ([2023](#b-9781474207935-032-0000108))

According to a friend at Microsoft this is known in AI circles as “eating its own seed corn”. According to the scientists quoted by Harrison, “it will drive the model ‘MAD’”. In my book *Art, Time and Technology*, I suggest that

the history of modern art can be read, at least in part, as a history of various artistic responses to the increasing speed and accelerating evolution of technology in the modern era and, secondly, that if art is to have a role or a meaning at all in the age of real-time technologies it is to keep our human relation with time open in the light of its potential foreclosure by such technology.

— ([2006](#b-9781474207935-032-0000102): 2)

Since publishing that book, I find the claim is still valid, perhaps even more so: thus, both the irony and necessity of discussing new media art in the pre-digital form of the book, the codex, arranged according to the linear affordances and the rules of order and grammar. Though it will of course exist digitally, and therefore be part of Google’s AI-readable universal library, it remains accessible to the human reader and their physical and temporal limitations.

### The Articles

The first part of this volume looks at the origins of new media art. Janis Jefferies examines the shifting role of hands and technologies in the active engagement with materials, and the different values in the production processes from handmaking to digital, as well as the evolution of crafts practices towards social, economic, ecological and cultural sustainability in the twenty-first century. Beryl Graham charts the way museums and galleries have (or have not) engaged with new media art, and aims to examine a range of museums and galleries in relation to new media art, not in terms of traditional institutional critique or a history of institutions, but rather in trying to trace the connections between institutions, disciplines, departments, roles and ideas, which go together to make systems of production, distribution and historicization. Catherine Mason looks at the history of new media art education, and how the unique position of computer arts within the history of modernism can only be fully understood in relation to the central role played by educational institutions. At a time when digital computing was in its infancy, it was educational institutions that provided a major point of access to this large-scale, expensive equipment and personnel. Ernest Edmonds’ essay shows how mathematics, and geometry in particular, have played a part in the visual arts for a very long time. He reviews developments from the nineteenth century to today, which have been extensive and quite revolutionary, both in mathematics and art to address the questions of why mathematics matters to art, what relevant innovations took place in recent times and what has the impact been on new media art. Andrew Pickering writes on cybernetics and systems, and how artists, from the 1950s onwards, and especially in the late 1960s—the heyday of the counterculture—and again now, have picked up on not so much the cybernetic vision in its entirety as aspects of it that spoke to them and distinguished it from the old artistic paradigms of painting, sculpture and music. Stella Baraklianou’s article explores digital photography, situating it within a line of continuation with that of its predecessor, analogue photography, looking historically where the two converge, but also demonstrating where digital photography has given rise to new and different categories to its predecessor. Chris Meigh-Andrew’s article provides an overview of the history of artists’ video, exploring its origins in Europe and the United States and tracing its development from its early and tentative beginnings to its rise as an international global phenomenon. The article outlines the numerous manifestations of artists’ video—including works for single screen, multi-monitor presentations and interactive installations—and identifies some of the key practitioners, influences, strategies and approaches.

Part 2, “The Digital Age”, starts with Nick Lambert’s examination of the development of high-technology art during the mid-twentieth century. The artistic encounters with many different types of technology resulted in numerous unusual and experimental forms that embodied the driving force of the age, and, from the abstract animators and Constructivists, a direct lineage could be traced to the mid-1970s and beyond. Simon Penny considers his experience of robotic art and the phenomenon of real-time computing as a new technological context that afforded a new kind of aesthetic engagement. He recounts his desire to build systems that were *lively*, not *life-like*, in an anthropomorphic or biomorphic sense. In his article Richard Wright asks whether computer animation constitutes a break with animation of the past or is it simply an extension of existing kinds of animation? Is the computer-animated image qualitatively different from previous forms of media art or only when incorporated into a platform which is more obviously new media, such as in an interactive installation, computer game or on networked media. He looks at this through animation’s relations to cinema and traditional animation, as well as through new practices and definitions. Ryszard Kluszcyński shows how the diversity within the field of new media art can lead to attempts at defining new media art by juxtaposing its numerous types. Kluszcyński suggests the best way of making such definitions is by indicating what unites them and makes them types of new media art. This requires identifying the properties that make new media “new”, that is, different from previous dominant media. Josephine Bosma looks at net art, a term for art made in the context of the internet, whereby context is interpreted broadly to also include offline components, objects and events. The role of the internet in net art ranges from technological to conceptual. Although the term itself was first used in the mid-1990s when the internet became popular, it is used to include works of art and art practices that existed earlier as well. Casey Reas writes about code art, the practice of which goes back to the 1960s at a time when access to the few computers in the world was open only to the engineers, scientists and researchers who worked at the corporations and universities who had purchased these massive, expensive machines. However, the *ideas* that are explored with the first art created using computers go back decades before, if “code art” is defined as a set of instructions that define an artwork. These instructions can be source code that runs on a computing machine, but they can be run in different ways, for example by other types of machines or read and performed by people. Linda O’Keeffe gives her account of new media art and music, exploring the question of sound art and its place within new media art history, showing how it has been shaped by many factors, some of which are negative, such as exclusion of access shaped by gender, class and race. She shows how sound as a listening practice has moved towards a somewhat non-hierarchical and more accessible medium with the development of non-academic pedagogical resources, and cheaper more accessible technologies, and traces a lineage of types of sound art practice while being as inclusive of artists working in the field as possible. Christiane Paul looks at art, on and about the World Wide Web, showing how art has had a continuous presence there and has critically engaged with or even contributed to the development of its potential for visual expression. Art on the Web is by nature embedded in the complex protocols and information spaces of the internet and, from its early stages, has often been about the network in that it has reflected upon its evolving processes, platforms and commercial frameworks. Paul Coulton’s article on the Network of Things, and how it has evolved from its origin with the use of RFiDs (radio frequency identification) and is now much more associated with the notion of “smart” products and services sold under the promise of making our lives easier and more efficient. Our ever-increasing entanglement within this Network of Things requires new ways of considering this space as well as offering potential new ways of creating and presenting media in this space, which is the primary focus of this article.

The third section of this volume assesses theories, with Barry Vacker and Kelly Bartsch giving a highly original account of media theory, which combines the ideas of Friedrich Nietzsche with Julia Hildebrand’s and Vacker’s own cool media theory, and theorizes Earthworks (also called “land art”) and telescopes as forms of Nietzschean new media art and technology, co-evolving in the deserts and dark skies of America and the world. Caroline Bassett looks at cyberfeminism and how the early media technologies of the twentieth century provoked questions concerning sex and gender: the politics of specific embodiment, the normative gendering of technology, issues of power, exclusion, affirmation, epistemology and ontology and continue to do so, and how cyberfeminism in the 1990s offered a specific set of responses to these issues. Stefan Herbrechter writes on posthumanism and how the late twentieth and early twenty-first centuries are characterized by what Richard Grusin has called the “nonhuman turn”. Thinkers like Donna Haraway, N. Katherine Hayles, Karen Barad—and many others—have changed their focus of attention to post-anthropocentric political and aesthetic practices, in which humans and non-humans co-exist, co-experience and co-produce in distributed cognitive environments, assemblages and networks of humans, animals, machines, software and environments. Olga Goriunova and Annet Dekker define and describe what they see as a key part of new media art in terms of absurdism and discuss how much of digital media art is absurd and that there is something about digitality itself that has a haunting sense of absurdity, with Western culture repeatedly finding technology, from mechanisms to automation, absurd. They focus on digital media absurdity and draw upon various artworks to endow the notion of absurdism with a density that does justice to digital media art. David Garcia writes about tactical media, a movement combining art, experimental media and political activism that shone brightly during the 1990s, in part through a revolution in consumer electronics in which the easy availability of devices such as the camcorder and PCs allowed a new breed of media makers to occupy the cracks that had started to appear in the monolithic edifice of mainstream media. Although the participatory ideal is increasingly contested it has deep roots for those who retain expectations of wider democratic engagement. Finally, in this section I offer my analysis of the importance of deconstruction and grammatology for the understanding of new media art. The emergence of digital technology is transforming our culture in ways that are hard to grasp. New media art and Deconstruction can both be considered as responses to the challenges of computerization and digital technology. The writings of Jacques Derrida and Bernard Stiegler, and others connected with Deconstruction offer the most profound engagement with questions of technicity that are particularly pertinent to our current technologized condition, as does art involving new forms of media, networks and technologies.

The last section deals with particular theorists, starting with an article on Marshall McLuhan by Chris Horrocks. McLuhan is famous for his dictum “the medium is the message”. His ideas on media had greatest impact in academe and popular culture in the early years of the electronic or “information” age in the 1960s and 1970s. In 1966, *LIFE* magazine, following a festival of contemporary art devoted to McLuhan’s work, noted how artists had begun to recognize the importance of his speculative explorations on media, the senses and the new electronic environment and dubbed him “Oracle of the Electronic Age”. Luke Skrebowski writes on Jack Burnham, an American artist, critic, theorist and educator who came to prominence in the 1960s, and whose historical and theoretical work focused on the interrelation between art, science and technology in light of the post–Second World War information technology revolution and the associated development of an information society. Burnham’s innovative work sought to theorize the post-medium-specific and post-object-specific character of postformalist art in terms of a relational ontology. The article on Roy Ascott by Lila Moore and Edward Shanken concerns the pioneering artist, primary theorist and pedagogical innovator of both cybernetic art and telematic art, who has served as a bridge between these scientific and artistic domains and played a key role in their histories since the 1960s. Ascott’s praxis straddles and exceeds modernity and postmodernity, proposing a “syncretic” paradigm that transcends those discourses, and adding a strong dose of mysticism. For Joseph Nechvatal the French philosophers Gilles Deleuze and Félix Guattari are the Wright Brothers of new media art theory. Deleuze and Guattari’s approach to aesthetics suggested a possibility of connecting people (both electronically and psychically) to the great chain of being—that which proceeds us and follows us—through a new approach to making and understanding postmodern contemporary art. “Bruno Latour” by Anders Blok and Line Marie Thorsen looks at Latour’s non-modern philosophical project of de- and re-constructing established dualisms of object and subject, nature and culture, technology and society, and offers up valuable conceptual resources for theorizing the affordances of digital and other new media, within and outside of his artistic mediation. Through his long-standing collaboration with Peter Weibel in curating several multi-modal exhibition events at the Zentrum für Kunst und Medientechnologie (ZKM) in Karlsruhe, Latour has himself become a topic of new media art–based investigation and critique. This section, and the book, ends with my account of Donna Haraway. Haraway’s Cyborg Manifesto is one of the most important contributions to our understanding of the meaning and potential of digital technology, particularly in relation to gender. However, I stage an encounter between the cyborg philosopher and the Goddess Feminism she is often understood to be in opposition to, and suggest that these ideas are now much closer than they appeared to be in the 1980s, especially in relation to notions of the digital occult.

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# Section I: Histories

# Part 1: Origins

The shifting role of hands and technologies in the active engagement with materials, and the different values in the production processes from handmaking to digital, have been widely addressed through a body of literature ([Latour 2008](#b-9781474207935-001-0000209); [McCullough 1998](#b-9781474207935-001-0000225); [Sennett 2008](#b-9781474207935-001-0000270)). This article takes the reader through some of the key ideas, noting strategic shifts through the writings of McCullough and Sennett in particular, and sections that note an evolution of crafts practices towards social, economic, ecological and cultural sustainability in the twenty-first century.

In Petiot and Braunstein Kriegel’s *Crafts: Today’s Anthology for Tomorrow’s Crafts*, a challenge is set:

Is there anything in common between an open source mobile laboratory in Belgium printing ceramics; the networking of researchers, lacquer specialist and designers motivated by a renaissance of plant lacquer in Asia. What is the link between the lotus silk extracted and spun in a women’s community in Cambodia, the baskets woven from telephone wire by craftspeople from South Africa in France, a royal manufacture founded in the eighteenth-century offering skills to a project by a Japanese designer?

— ([2018](#b-9781474207935-001-0000247): 15)

The quote raises many important questions as it maps out the increase in connections between craft, art, design and manufacturing that parallels dramatic shifts in the global economy. At the same time, many essays in the anthology note that a great deal of contemporary interest in every aspect of the handmade has found a variety of expressions through individual, collective by rethinking the local in relation to the global. Essays by [Brewerton (2018)](#b-9781474207935-001-0000114), [Chuenrudeeol and Boonla-Or (2018)](#b-9781474207935-001-0000133) and [Voharn (2018)](#b-9781474207935-001-0000284) evidence how local materials, their origin, use and new technological platforms, offer an alternative economy located at the intersection of soft power, the vitality of cultures, an improvement in living conditions and the overhauling of our relationship to ecology. To this end, and in defence of the notion of ‘diffuse craftsmanship’, Petiot and Braunstein Kriegel argue that local production and the global economy are connected although on different scales and at different levels. They propose strategies of reconciliation between production, culture, the environment and consumption. Some of these issues will be addressed in this article alongside different forms of craft activism: for example, rebellious and tactical uses that can be found in the Do-It-Yourself (DIY) and DIT (Do-It-Together) culture and hybrid forms of making, led by online and offline maker communities at local and international levels. There is a growth in early career and established writers and scholars on this subject. They range from ‘Experimental Communities’ ([Basualdo and Reinaldo 2009](#b-9781474207935-001-0000095)) on the recent proliferation of participatory projects, social entrepreneurship and activism to Anderson’s 2014 account of a crowd-sourced project that gathered together traditionally beaded moccasins and lobbied for disappeared Indigenous women in Canada. Anna Dezeuze’s 2012 edited collection of essays on *The “Do It Yourself” Artwork: Participation from Fluxus to New Media* further reflects this trend.

## Resetting the Field of Craft Practices: Materials and Skill

The cultural connotations of craft have varied throughout the history of Western ideas. Once the primary means of producing functional objects, the role of craft changed significantly following the Industrial Revolution in nineteenth-century Britain, a period that historians such as David Olusoga and Sven Beckert are revising, expanding and rewriting (see [Olusoga 2016](#b-9781474207935-001-0000238) and [Becker 2015](#b-9781474207935-001-0000100)). Both authors address the history of capitalism, including its economic, social and political dimensions, establishing that nineteenth-century American slaves picked cotton to support the cotton mills of Lancashire in the UK that thrived as part of the Industrial Revolution.

In the face of advanced mechanized production, in Britain in the nineteenth century, America in the twentieth and China in the twenty-first hand skills became less central to production, and design—traditionally unified with the role of the artisan—emerged as a separate discipline. Despite the arrival of mass production, craft has endured, both as a leisure activity and as a set of valued artisanal practices. This endurance is acknowledged by an ever-increasing network of experts, writers, critics, academics, journalists and artists writing in such reviews as *Crafts* magazine, *The Journal of Modern Craft*, *The Journal of Crafts Research* and *The Journal of Design History*, whose editors give the reader a variety of opinions from a number of perspectives. This provides textual depth on all aspects of craft and its future importance to different sectors of culture and the economy: including the relationship between craft and design and the place of thinking, making and new knowledge in a world where ideas of slow and time are embodied. For example, in 2007, Helen Carnac was commissioned to curate “Taking Time: Craft and the Slow Revolution”, a project for the British crafts organization Craftspace, a craft development agency based in Birmingham, UK. Craftspace continues its innovative work in collaboration with many digital artists and makers, establishing online workshops themed to relate to a human value or experience, such as courage, care, connection, loss and emotional repair. Devised by the artist Alinah Azadeh, both a media and crafter, her residency in Balsall Heath, Birmingham, has been moved online into the resource-in-common and the national touring exhibition “We Are Commoners” (2021).

Further afield, Amor Muñoz devised the installation *YUCA\_TECH: Energy by hand*, which focused on alternative forms of production through collaboration with an intergenerational group of women crafters in a small village located in the Yucatan in the zone where the native henequen plant grows (Maya region), Mexico. As explained in her Zoom talk of April 19, 2021 for the Centre of Heritage, Arts and Culture, Hong Kong, Muñoz designed a community technology lab. The idea was to create technology-based artworks using solar energy that combined Indigenous crafting techniques with open-source technologies and new materials. Maya women were able to make their living crafting hammocks with pre-Hispanic techniques and raw end materials (henequen maguey) and open-source solar panels. The group of women created artefacts that would benefit their daily life, for example in the workshop they created lamps and flexible solar panels which were easy to transport and could protect them from the environmental conditions of the region. The YUCA\_TECH: Energy by hand project strengthened the community by using low- and high-tech resources. The manufactured objects span solar textile panels, everyday objects with solar-powered LED light (hats, sandals) and some solar handbags designed to collect electricity. Muñoz’s other projects, including Oto-Labs: Applied Crafts and Chihuahua-Tech LAB, are further examples of how technology can be a tool to revalue and preserve craft traditions to empower communities. For example, “Maria dolls” obtained a resignification and revaluation when they were combined with electronics. Now the traditional crafts are not only toys, but also work as a lamp and can be recharged with solar energy. The regular Maria dolls cost $9 USD, the photovoltaic Maria dolls cost $80 USD. The first edition of technological dolls sold out and currently the artisans are working on a new production.

Both Alinah Azadeh and Amor Muñoz have worked with their communities to create different but complementary kinds of aesthetic, economic and social care, combining making, craft traditions rooted in time and place.

As Glenn [Adamson (2013)](#b-9781474207935-001-0000084) has argued, artisanal practice is indeed intrinsic to the “slow movement” and craft tradition is often understood as rooted in place. Any consensus around words such as “skill” or “handmade” is quickly complicated by the words “skill” and “handmade” that are embedded in the crafts, but what do they mean? The words themselves are loaded with values and preconceptions, discussed in many key texts, such as Glenn Adamson’s *Thinking through Craft* and *The Invention of Craft* (2007, [2013](#b-9781474207935-001-0000084)), Richard Sennett’s *The Craftsman* ([2008](#b-9781474207935-001-0000270)) and Tanya Harrod’s *Craft* ([2018](#b-9781474207935-001-0000179)), which contains seminal essays by John Roberts and Ulrich Lehmann on skilling and reskilling and making as knowing respectively, published in the series Whitechapel Documents of Contemporary Art documenting major themes in contemporary art. The editorial review produced by the then editors (including Adamson and Harrod) for the *Journal of Modern Crafts* (JMC) in 2017 discusses the range of submissions over a decade of publishing including new technologies of making and geographical differentiation: readers are encouraged to delve into the essays by Suzette Wolfe [Wilson (2010)](#b-9781474207935-001-0000300), Irene [Stengs (2012)](#b-9781474207935-001-0000273) and Hwei-Fen [Cheah (2013)](#b-9781474207935-001-0000128). The essays conclude with suggested areas of enquiry for future craft scholarship, most notably in the disparity between different craft cultures and respect for Indigenous agency ([Murray 2010](#b-9781474207935-001-0000233)) and the significant shifts in how craft is examined through multiple immigrant communities in the USA ([Wiggers 2014](#b-9781474207935-001-0000294)).

Not only is craft materially based but for many makers and writers *material matters*. It has a physical reality and embraces sensual experience; it carries symbolic meanings and has aesthetic and economic value. Further, as argued by the sociologist Richard [Sennett (2008)](#b-9781474207935-001-0000270), making craft encompasses the desire to do things well for its own sake, whether potters making mugs or lotus silk weavers in Cambodia. For Sennett, physical making is highly pleasurable and an essential part of what it is to be human. We need craftwork, Sennett suggests, to keep ourselves rooted in material reality, evoking extraordinary human experiences so intimately related to touch that no machine can replicate.

There are undoubtedly issues concerning the loss of direct manipulation of materials. The breaking of a continuous, experimental feedback loop provided by the sense of touch has been highlighted by [Dormer (1997)](#b-9781474207935-001-0000159), [Johnson (1997)](#b-9781474207935-001-0000193) and others as a challenge to one of the defining features of craft. For them the “handmade” object embodies a particular type of knowledge born from direct personal engagement with materials, which is unique to craft practices. Although Johnson argues that craft is an important means of sustaining the “literacy of touch”, she recognizes that “touch” as a concept can be considered beyond immediate physical contact. Johnson concludes:

by understanding more fully global touch, reach-touch and imagined touch, we may find a more fruitful way to locate and articulate crafts in relation to information technology. This relationship might not be an oppositional one, but more independent.

— ([1997](#b-9781474207935-001-0000193): 298)

However, experiences of the “handmade” have increasingly become embedded in slow time, a cultural shift towards slowing down the pace of life. Martina Margetts considers questions of time and process, economy and material, touch and experience, in “Taking Time: Craft and the Slow Revolution” ([2010](#b-9781474207935-001-0000217)). The sense of touching material and human touch is conjured when humans can no longer physically do so for fear of infection and transmission at a time of crisis and lockdown during the COVID-19 pandemic.

But shaping physical materials with one’s hands addresses the role the hand plays in digital making, which can also be an intuitive process. Craft is eulogized from the perspective of man (and Sennett always uses the male pronoun) being deeply aware of personal sensations and experience. This is Sennett’s appeal to be back in touch with your body, even if participating in Linux, a system of “open-source” computer software, online workshops.

Nonetheless, when we craft, we experience the feel of the carving knife working through a piece of wood, a needle moving through cloth, or our fingertips pressing into clay, the grip on the pencil, the pressure on the chisel: Sennett persuades his reader that these things have real significance. Above all, the decisions that are made during the craft process are altered by the feel of working with the material. This is what might be named as tacit knowledge ([Polanyi 1966](#b-9781474207935-001-0000250)). Things happen intuitively, before and in and around linguistic process; knowledge embedded within the crafted object is transmitted from the maker to the user. Intuitive leaps, specifically their capacity to draw unlike domains close to one another, preserve tacit knowledge in the leap between them. As Donald Schön maintains, “our knowing is ‘in’ our action” ([2013](#b-9781474207935-001-0000264): 49). In the move from “reflecting-on” to an analysis of “reflecting-in” crafts practice, we might close in on what Csikszentmihalyi has referred to as “flow”, a state in which a person is “so involved in an activity that nothing else matters” ([Csikszentmihalyi 1996](#b-9781474207935-001-0000153): 4).

## Co-Elaborative Intelligence

According to Leonardo Bonanni and Amanda Parkes, the significant point for their research ([2010](#b-9781474207935-001-0000106): 179–90) is that Sennett’s ideas allow them a way into crafting the digital. For them, craft encompasses a much broader context than skilled labour and promotes an objective standard of excellence in which craftspeople are shapers of culture, policy and technology. They argue that the nature of craft is transdisciplinary; it is rooted in emerging materials, technological processes and cultural phenomena. Crafts are uniquely positioned to reflect new social values. In the crafting process, this means acknowledging that digital technologies are malleable and full of potential to become something else. This knowledge is then integrated into the creative process. Craft is not just about making objects, but signifies a condition of deep engagement. It is more than being bound to a particular practice.

At one end of the spectrum, traditional craft can be defined as the art of making by hand, the less mediation by the tools, the most conventional the craft becomes; but at the other end of the spectrum, technological advances and the mediation of tools become an intrinsic part of the process. Neil Mendoza and Anthony Goh’s *The Haunted Typewriter*, first shown in “Unleashed Devices” (Watermans Arts Center, 2010), proved so compelling that it might also be framed according to the discussion as proposed by what Christopher Claudwell also called “Craft-fetishism, ‘nostalgia’ for object-based practices” ([1937](#b-9781474207935-001-0000142): 111). An antique typewriter has been brought to life with over thirty actuators, an exploration of a device’s character and our attitudes and use of “behaviours” towards it. This point is taken up later in the section on “Crafting the Digital”, but now I want to return to a generic crafts environment and look at how the Do-It-Yourself (DIY) communities have been reviving and renewing craft by integrating analogue and technological crafting processes with often political and “rebellious” tactics.

## Revival and Renewal: Rebellious Craft, Robotic Initiatives

There has been a resurgence of interest in craft skills in a DIY culture, digital fabrication and hybrid forms of making. Emerging, digital technologies have provided new tools and ways to engage, particularly in hobby crafting. Indeed, today’s hobby crafts are frequently concerned with material mediated via the internet and accomplished with the aid of software, which also affects our understanding of maker identities in online communities, which lead the DIY culture.

David [Gauntlett (2011)](#b-9781474207935-001-0000170) presents such a case in *Making Is Connecting: The Social Meaning of Creativity, from DIY and Knitting to YouTube and Web 2.0*. ([2011](#b-9781474207935-001-0000170)). His book traces a continuum of crafts practice through to the digital age of blogging, social networks and making videos for YouTube. He suggests that engaging with Web 2.0 technologies is an example of “everyday creativity” that helps bring people together to make and innovate. Three definitive motivations are outlined for making and everyday creativity: 1) pleasure and an enhanced sense of self as creative agent; 2) feeling alive in the world through the ability to do things as an active participant engaged in dialogue with a community; 3) recognition by like-minded people.

Sarah Corbett, a founder member of the UK Craftist Collective, defines craftivism as “a way of looking at life where voicing opinions through creativity makes your voice stronger your quest for justice more infinite” ([2010](#b-9781474207935-001-0000145)). In the UK, in the BBC FOUR documentary (*Craftism: Making a Difference*, Wednesday February 3, 2021) narrated by the comedian Jenny Éclair, Corbett articulates her vision alongside those crafters stitching tiny, groovy knickers to urge women to go for smear tests, and sending bandages to MPs to make visible the fact that carers are a perennial bandage between the UK’s National Health Service and local authorities. The small point was that none of the crafters were clicking on a “like”, or half-smiling at a meme, but crafting on- and offline, with quiet political insistency. Creative, political protest is not a new idea as there has been a long and inspirational history of craft being used to tackle poverty and expose social injustice, as *The New Politics of the Handmade* ([Black and Burisch 2020](#b-9781474207935-001-0000103)) acknowledges.

Thus one argument runs along these lines: that the resurgence in handcraft is simultaneous with a global growth in electronic communications. While this conjunction with traditional handcrafts in the age of electronic computing may appear to be somewhat paradoxical—the internet has eroded the absolute necessity of a central, collective work in a physical place and in a specific place—it has provided virtual connectivity for independent crafters who can be both independent and collective simultaneously. The plethora of blogs and widespread interest in crafting is but one example of this rejuvenation. Powered by the capacity of the internet to connect online communities, it has now become a worldwide phenomenon claimed to be at the forefront of a new industrial revolution—the makers’ era ([Anderson 2014](#b-9781474207935-001-0000092)).

It would appear that for many crafters, like Azadeh and Muñoz, the contemporary practice of craft is firmly placed in the language of empowerment, economic sustainability and well-being. There is a belief in the idea of the democracy of the internet and that its non-hierarchical and decentralized format can promote different forms of activism through technological engagements, debate and markets. In 2009, Elinor Ostrom was one of the winners of the Nobel Prize in economics. Her analysis is about identifying the character of a successful commons that can deliver joint benefits. In *Governing the Commons* ([1990](#b-9781474207935-001-0000244)), she set forth some of the basic “design principles” of “effective, durable commons” that became a basis for experimentation also in craft and design. Bruce [Metcalf (2008)](#b-9781474207935-001-0000231) argues along these lines, without the emphasis on economic analysis, but in agreement with managing common-pool resources. In his article “DIY: Websites and Energy: The New Alternative Crafts”, he suggests that craftivism is anti-globalist, anti-corporate, green, enthusiastic about any attempts to get off the grid and deeply sympathetic to populations who feel marginalized from the mainstream, the politically oppressed and economically impoverished. Metcalf argues that the oppositional impulses behind craftivism pre-date the 1960s, citing William Morris, the founder of the Arts and Crafts movement, who had become one of England’s leading Socialists in the 1880s, and a very early opponent of industrial pollution. Craft and capitalism have always been tied together; Metcalf notes that craft has always advocated capitalism on a very small scale, with modest investments and face-to-face marketplaces. This is small money, small footprint, intimate capitalism, designed to solve one of the most urgent questions posed dramatically during the COVID-19 pandemic where, in terms of international trade, global financial systems have continually transferred wealth to the Global South ([Varoufakis 2020](#b-9781474207935-001-0000281)).

“Robotics and artificial intelligence are the next revolution”, says Rajiv Kumar, an economist and founder of the Pahle India Foundation. “They are going to be more disruptive than any of the revolutions we have seen in the past—steam, electricity, the assembly line or computers—because they are going to replace not just routine but complex mental functions. The fear is that our so-called demographic dividend could become a demographic nightmare” (quoted in [Lillington 2017](#b-9781474207935-001-0000207)).

## Well-Being, Health and Ethics

There is a further dimension to this discussion, which focuses on mental health and well-being. Embroiderer Ekta Kaul and maker Joe Hartley have discussed how their personal practices have changed under COVID-19 lockdown. The online activities they have been running are aimed specifically at supporting well-being and mental health challenges (BBC Front Row, May 1, 2020).

Significantly, too, there is a greater awareness and promotion of ethical approaches advocating sustainability, ecological, local production and development. One further example, launched in 2017, is the Tempestry Project, a response to the Trump administration’s hostility towards climate science and fears about what that could mean for federal climate data ([Wadja 2020](#b-9781474207935-001-0000290)). Shortly before Trump’s inauguration in 2016, guerrilla archiving events began popping up nationwide in an effort to scrape government websites and create backups of their data. Reading about these efforts, a group of women knitters decided to start archiving climate data for themselves. The group’s first “Tempestry”—a scarf, or tapestry if you prefer—used a rainbow swath of colours to depict temperature data collected by the National Oceanic and Atmospheric Administration (NOAA)—in the spring of 2017. At first, these climate crafters simply shared photos of their work, along with their patterns and where to buy the yarn they were using, on Facebook. But as interest started to swell across the local and online knitting communities, it was decided to make it easier for would-be data knitters around the world to get involved in a website and Etsy store that sell custom climate-data tapestry kits for purchase and they developed a how-to guide on requesting the temperature data directly from NOAA.

Embroiderer Fleur Oakes identified techniques from her skill set that could improve surgeons’ control over fine sutures when they join arteries together. In 2017, Oakes was lacemaker in residence at the vascular surgery unit at Imperial College’s St Mary’s Hospital in London, where she worked with the clinical team to devise an educational programme aimed at overcoming problems with thread tangling during surgery. The collaboration, directed by Roger Kneebone, Professor of Surgical Education and Engagement Science at Imperial, articulates the relationship between seeing and doing. Under its aegis, bioscientists and clinicians in the divisions of computational medicine and surgery work with craft-based practitioners and academics from the Art Workers’ Guild’s Victoria and Albert Museum Research Institute to explore common ground in how we learn with our hands and touch. Research on science and craft is beginning to be published, as in Kneebone’s recent book, *Understanding the Path to Mastery* (2020), and Julian Kiverstein and Mark Miller’s article “The Embodied Brain: Towards a Radical Embodied Cognitive Neuroscience” ([2015](#b-9781474207935-001-0000199)). Trainee orthopaedic surgeons work with stone carvers to gain the physical experience of working with sharp tools to carve and learn to “read” the materials they are working with, whether rooting around in a patient’s gut or through medical applications, such as Frostick’s bio-implantable device for reconstructive shoulder surgery, which uses lacework with a modern-day medical material to create a supple and compliant implanted brace for damaged shoulder muscles ([McQuaid 2005](#b-9781474207935-001-0000228)).

In her 2011 book *Advanced Textiles for Health and Well Being*, Marie O’Mahoney presents the case for advanced textiles as having the potential to transform and support personal health and well-being. In many instances in the UK, researchers have been exploring the new frontiers in materiality through the emerging domain of soft robotics using design thinking methods. What might these be? One example, among many, can be found in Amy Winters’article, “Design, User Experience, and Usability: Technological Contexts” ([2016](#b-9781474207935-001-0000305)). She describes her work and advocates embodiment as a design methodology and physical computing using tacit crafted textile expertise.

Craft is at the core of the process through a combination of materials and design skills and further exemplified by a different kind of “Lab Craft: Digital Adventures in Contemporary Craft”, a touring exhibition curated by Max Fraser for the Crafts Council, UK, in 2010–12 and which contains a very useful glossary of terms. As Max Fraser points out in his introduction to *Lab Craft* ([2010](#b-9781474207935-001-0000167)), the handmade and computer-programmed machines are sometimes seen as being in very different spheres. The work of twenty-six makers from woodwork through textiles to jewellery were on display. What they all had in common was the use of rapid prototyping, laser-cutting and digital printing to augment their practice. A piece by Michael Eden called *Babel Vessel* was made from nylon with mineral coating and, at its top, a digital pattern was cut out, behaving like code. By downloading an app to use with a smart phone the pattern could be photographed, which in turn brought up a website about the exhibition. There has also been a revolution in personal and digital manufacture, through Fab Labs equipped with 3D digital tools, laser-cutting and milling. A Fab Lab is a digital fabrication laboratory, created in 2001 by the Massachusetts Institute of Technology (MIT) and part of the global “Do-It-Yourself” movement with the philosophy of making instead of buying. Compared to highly capitalized industries, where there is considerable investment in equipment and a high level of specialization, multi-skilled makers working in small-scale environments are extremely adaptable. Such co-option, manipulation and distortion of these tools revel in experimentation.

## Hacker Culture and the Birth of Arduino

The growth of hacker culture and its communities has inspired a new group of craft creatives to evolve and enter the technology industries as inventors, sole traders, start-ups and co-operatives that operate as different to the global financial systems now in collapse. These creatives are a diverse mix of people, from graduates emerging from universities to crafters, designers and artists plus entrepreneurs creating new start-ups or those re-engaging with technology: they celebrate new ideas, devices and uses for technology, many in the realm of wearable technology, crafting Arduino cap and physical computing. They investigate new ways to run businesses and business models, changing the path from prototype to manufacture. In some respects, such creatives embody the idea of the “creative life”. The term was first introduced by economist Joseph Schumpeter ([1942](#b-9781474207935-001-0000267)) through his concept of “creative destruction”, and it can be read as an ideological cover for the shift in labour conditions, expressed through the innovator-crafter as a creative entrepreneur. Innovation drives globalizing economies but how can the artists’ creative life and turbulent talent be harnessed and sustained? It can be argued that the “craftsperson” is an innovator and risk-taker. Schumpeter was not looking at things theoretically but at the practice post-1930s and 1940s and saw that without innovators there was no key to kick-start the economy, albeit potentially a disruptive one, disputing that the business process could run by itself. Sharing the economy is also a communitarian idea that connects to Elinor Olstrom’s and Bruce Metcalf’s views cited previously.

Massimo Banzi co-created a micro-controller board and coding environment called Arduino (descended from the Wiring project) for designers. Its purpose was to help them quickly create hardware prototypes. There are a whole range of Arduino micro controllers that allow craftspeople, for example, new to electronics and coding, to develop their own hardware projects. As part of the Intel, People and Practices “Things That Matter” research programme from 2007 to 2017, a number of students working in the Goldsmiths Digital Studios labs, like Roger Meintjes, used Arduino micro controllers to produce TagMat—A Construction Kit for developing Interactive Story Mats (2009), using Arduino, XBee and a Parallax Reader that linked storytelling, crafts and learning.

## Crafting the Digital

The term “digital craft” is generally applied to denote the design and fabrication of physical artefacts by the use of digital tools, such as CAD, digital clay, 3D printing and CNC laser-cutting, as the “Lab Craft”, exhibition researched. [Jacobs et al. (2016)](#b-9781474207935-001-0000182) apply the term “Digital Craftsmanship” very broadly, encompassing computer-aided design, electronic crafts, procedural design and hybrid human-computer in addition to digital fabrication.

Malcolm McCullough has explored the idea of digital craft over the last three decades, addressing the role the hand plays in digital making. As he has argued in *Abstracting Craft: The Practiced Digital Hand* ([1998](#b-9781474207935-001-0000225)) through tacit skills and knowledge, there could indeed be a positive correspondence between digital work and traditional craft. So that, as well as the build-up of tools within tools (filters in software), not only does digital craft enable makers to navigate a continuum of possibilities through iteration and rapid prototyping, using the computer’s ability to accurately re-create a thing over and over without breaking—“computation makes autographic media allographic” (ibid.: 102). McCullough’s argument is significant in presenting the idea that hand and brain activities involved in computer use are specifically analogous with craft practice. He proposes that computer systems should be developed from the perspective of the user, allowing them greater flexibility to work in the computer medium through the use of more refined and sensitive software tools, and eventually through haptic devices and virtual reality. McCullough has spoken to the need that in a post-industrial society close observation and understanding of human experience of the material world and of each other are central issues in designing for the twenty-first century.

What is useful about McCullough’s writing, and Tanya Harrod’s reading of it in her essay “Otherwise Unobtainable: The Applied Arts and the Politics and Poetics of Digital Technology” (2008), is the suggestion of craft and computing becoming co-dependent and interconnected. This view finds some support in Rafael Cardoso’s research: “Craft Versus Design: Moving Beyond a Tired Dichotomy” takes up the challenge by suggesting, “perhaps design and craft will become synonyms too: complementary aspects of the same ongoing process of shaping experience through the interaction of people and things” ([2010](#b-9781474207935-001-0000122): 331).

In other words, craft is procedural and open to risk. If fabrication and digital craft are seen as the completion of an idea that is then constructed by the machine, the most valuable aspect of craft is lost to overdetermination. So this point illuminates Schumpeter’s insights previously cited, because the key to the engine is the innovation of the “crafter” and her collective of makers, not some imaginary hand in the digital process. Simulation can sidestep this overdetermination but it is a poor substitute for tactile experience. If the digital is used to eliminate the feedback loop of question finding through question answering, then craft itself is at risk. Machines break down when they lose control; whereas people make discoveries, stumble upon happy accidents. One of the most noticeable differences in using computers as part of craft and design compared to traditional craft is the shift of power from the hand to the eye, a synthesis of the haptic and the visual, in the act of perception—in a broad sense, to give way for the maker to work with mental models and processes.

While impoverishing the use of the hand’s dexterity to a mere pointing and on–off devices such as mouse and keyboard, the notational capabilities enabled in computing allow for structure and symbol manipulation through abstraction, thus giving a whole new dimension to the process of making.

At the heart of human control through continuous process is tool usage and craft practice. For example, Object Oriented Programming makes parameterization possible by allowing direct symbol and structure manipulation, to define an object with a set of properties of a certain nature and allowing for those properties to change and allow for richer iteration processes and more informed decision making ([Jefferies 2017](#b-9781474207935-001-0000185): 4).

## Computational Craft: Mind Tools and *Minecraft*

While computing is used in all sorts of craft processes, informing the practice and extending the field by applying tacit knowledge in new ways and by new means, computation can be considered as tool, process and medium all at the same time. According to David Crow, “programming—despite its abstract nature—has the properties of a concrete craft practice”. He states, “craft is so often described as a practice surrounding a specific set of materials. But in truth it is less the material that defines the practice as the process of play, experiment, adjustment, individual judgment and the love of material—any material” ([2008](#b-9781474207935-001-0000148)).

An important point to make here is that there is a level of integration of person and tool, similar to David [Pye’s (1968)](#b-9781474207935-001-0000259) experiences of working with risk. There is an ebb and flow between tool, material, hand and mind, a tacit knowledge. As Karen [Yair (2011)](#b-9781474207935-001-0000311) states, ideas around craft are that knowledge is embedded in processes. There is another dimension to this discussion: a level of integration of person and tool, material and knowledge moves away from the singular practitioner bringing the crafted artefact into existence, to co-dependent and collaborative processes of practitioner/tool/world. This idea of co-dependency arises from the work of [Varela, Thompson and Rosch (1991)](#b-9781474207935-001-0000278), which questions the traditional boundaries and models of mind and body through research undertaken in cognitive science. The main challenge when making is to find and to hold the final intentions and purposes of what I am creating as thoughts, still in a state of mental models and processes, while creating the abstract structure necessary to externalize those processes and models through lines of codes. This is both a challenge and a curse, as it is nearly impossible to dissociate the inner workings of the thing created from the way it is made. Nonetheless, these developments have created a space for people like Andy Clark to identify “mind-tools” ([2002](#b-9781474207935-001-0000139)), and study the ways in which we might think-with or think-through objects. Meanwhile, since the introduction of the agency of things, objects, including crafted and designed, are starting to play a more pivotal role within social organizations and identity, creating complex networks, systems and webs of people and things.

Returning to [Bonanni and Parkes (2010)](#b-9781474207935-001-0000106), their position is that the open-source software movement is a social organization, a complex network, that resembles the historical craft guilds, except they are not necessarily closed societies wanting to keep a competitive, economic edge. While the transmission of physical skills and resources is enabled via the internet, as in the examples given above in the “Revival and Renewal” section, there remains a deep connection between people and the things they craft or design. Knowledge, tools and ideas are dispersed through webs of interconnectivity and innovation. What might be termed “collective intelligence” has a twofold effect: reshaping a historical model/evolution of craft and design and made-things in the West to creative processes through explicitly thinking about tools for thought. Think about the popularity of multi-player computer games, where they refer to a collective task-oriented approach coordinated through the internet.

There was once a tremendous anxiety surrounding the effects of computers on the next generation of craftspeople. Frank Wilson wrote, “The fully computerized kid may turn out to be just like us or strikingly different, as a consequence of hands replacing haptics with vision as the primary arbiter of reality” ([1998](#b-9781474207935-001-0000297): 289).

In his study *The Hand* ([1998](#b-9781474207935-001-0000297)), Wilson goes on to discuss the intimate connection between the hand and cognition, after all the brain does not live inside the head but reaches out of the body and into the world. The neurological evidence is showing that active action, especially as complex as handmaking processes, has vital cognitive benefits over a lifetime. I consider that this is what Sandra Alfoldy had in her conceptual framework when observing her then 9-year-old son playing *Minecraft*. Alfoldy argues that “video games … encourage not only improvements in motor skills that lead to increased hand-on craft talents”, but also, “performance superiority and improvement in many visual and spatial tasks” ([2017](#b-9781474207935-001-0000087): 4). It is all about algorithms: the day–night cycle, the steps needed to craft items, the way tools work and break. Most children won’t necessarily be thinking in terms of algorithms but they’ll be exposed to them and challenged to understand the core components of computational thinking, for example logical thinking, abstraction, pattern identification, predicting, human–computer interaction and hardware/software integration. It’s common in the community for players to build maps for others to experience. These could be adventures, stories or puzzles. In Alfoldy’s commentary, and watching her son play *Minecraft*, players use craft, and make textiles utilizing texture packs to make personal textile surfaces and finishing touches to furniture and all kinds of interior design.

The virtual world *Second Life* has its own economy. Established by Linden Lab in the USA, a virtual token, referred to as Linden Dollars (L$), enables users (called “residents”) to buy and sell to one another directly, with the Linden Dollar only valid within the *Second Life* platform. Linden Dollars have no monetary value and are not redeemable for money from Linden Lab. This economy is independent of the price of the game, which users pay to Linden Lab, not to each other. If we think about the basis of this economy, *residents* (i.e. *users*) could buy and sell services and virtual goods to one another in a *free market*. Virtual goods include clothing, skin, hair, jewellery, flora and fauna. To earn Linden Dollars in *Second Life*, one must find customers who are willing to pay for the services or products that one can supply, just like in real life. This is a particular kind of economy, one in which a free market economy is stimulated, but what other kinds of economic strategies are there in respect of digital craft?

## Conclusion

Combined with traditional crafts and artistic invention, the application of haptic skills and manually controlled skills ([Jennings 2012](#b-9781474207935-001-0000190)), crafts within a creative economy can have a global impact on the relationship between production, culture, the environment and consumption. The use of locally appropriate crafts activities as a strategy for economic development or individual survival has a long history and is usefully analysed by Susan [Luckman (2015)](#b-9781474207935-001-0000214). Ideas about sustainable production, ethical living, cultural industries and everyday life surface as an economic strategy when times are tough, and unemployment is high, as is the current world situation. This seems to indicate the desire to reassert local control to counteract external forces. It also indicates the strategy of mobilizing local resources and empowering people with the confidence and means to build a sustainable future based on what they have to offer. In the 2020 and ongoing global pandemic known as COVID-19, small and medium-sized enterprises (SMEs) may find themselves able to connect centres of excellence at a local and international level. The potential relationship between the local and international can be viewed as complementary. Rural culture has the possibility of being integrated with all tools and forms of digital technology and platforms for new business models as is discussed in the UK’s Arts and Humanities Research Council research project Digital Platforms for the Crafts, which is concerned with re-evaluating the role of crafts in the twenty-first century and is proposing digital technologies and design methodologies to enhance maker production, visibility and distribution. The project was carried out by an international team including Prof. Nick Bryan-Kinns and Dr Yuanyuan Li from Queen Mary University of London (UK) and Prof. Hao Tan, Dr Zhengyu Tan, Dr Duoduo Zhang and Ying Zhao from Hunan University (China), with a host of students from both universities contributing to its findings. The author wrote one of the prefaces to the published report ([Bryan-Kinns and Li Yuanyuan 2020](#b-9781474207935-001-0000120)) and observed that both the UK and China have distinct and different craft practices and heritage, rich traditions of making in and understanding of wood, bamboo, ceramic, cloth and metal. Many examples of reviving handcrafts for economic sustainability as well as cultural preservation are given in the report cited.

Daxi Leather Studio was established in 2015, located in Bolinjingu District, Changsha. The founder, Hong Daxi, graduated from the Architectural Design Department of the Chinese Academy of Art, and is a member of the Young Craftsmen Alliance. Digital devices used in the studio include iPads, mobile phones, computer and camera. The studio uses different digital design software, including Auto CAD®, Adobe® Photoshop, Adobe® Illustrator on computers. Taobao Live, which is a Chinese e-commerce platform with live-streaming service, is one of the digital platforms Daxi uses to promote its product.

China also has emerging digital technology oriented multi-maker communities, whereas in the UK such communities, like the Craftist Collective, have been vibrant and highly visible in their activism for a decade. What is important is that both countries and communities, according to the findings of the comparative study, have not only started to apply digital production and design software to their maker skills, but also recognize that crafting and design thinking are essential to future survival. This implies that thinking and problem solving encompass an understanding of what people may need, either through forms of public engagement to devise new prototypes or by investigating the different platforms that are currently in use. These could be through social networks, 3D printing, laser-cutting, digital software (CorelDRAW® or SketchUp) and online marketplaces. Etsy, for example, is an American e-commerce company focused on handmade craft, supplies and tools, while JingDong is a large Chinese online retailer, e-commerce company, based in Beijing. Machinic entanglements, the partial knowledge of the state of two systems, in this case craft as physical objects and computational creativity, are insufficiently examined whether in the current UK government’s policy or practice. As Digital Platforms for Craft concludes, digital platforms such as social networks and online marketplaces are key to enabling growth in the Creative Economies and applied across Creative Economy sectors crafts. Accordingly, for those concerned with physical objects, digital platforms provide opportunities through the fourth industrial revolution, a digital evolution characterized by a “fusion of technologies blurring the lines between the physical, digital and biological spheres” ([Weiss 2016](#b-9781474207935-001-0000292)). Weiss emphasizes the recognition of multiple modes of production, and consumption, of the modernization of artisans, and of combining craft and design. Craft practices are not static, but are capable of continuous evolution, transformation and adaptation, as this article has aimed to explore.

To return to the beginning, Petiot and Braunstein Kriegel’s final commentary to their section “Local Production, Global Economy: Craft on Different Scales” ([2018](#b-9781474207935-001-0000247)) proposes a number of strategies of reconciliation between production, culture, the environment and consumption with those that are often celebrated by the craft sector: risk-taking, investment and technological innovation. They ask how small and medium-sized enterprises can help one another and how the roles of centres of excellence at a local as well as international level can be complementary. They imagine an integration of rural culture and cutting-edge technology, running concurrently with a raised awareness of inequalities on a global scale. A new “humanitarianism” is addressed that, combined with a change in production and consumer habits, permits environmental accountability, economic viability and well-being.

While this summary may read in a similar vein to Yanis Varoufakis’s *Another Now: Dispatches from an Alternative Future* ([2020](#b-9781474207935-001-0000281)), as a utopian vision of a world having to rebuild itself and rethink its values, it is worth noting *The Economist*’s leader column reported that tomorrow’s factories may look more like weavers’ cottages than Ford’s assembly line ([Markillie 2012](#b-9781474207935-001-0000222)). Or, as expressed in the European Parliament resolution “Towards an Integrated Approach to Cultural Heritage for Europe” ([European Commission 2014](#b-9781474207935-001-0000165)) and RICHES, European Policy Brief’s “Towards a Craft Revival: Recalibrating Social, Cultural, Economic and Technological Dynamics” ([2016](#b-9781474207935-001-0000262)), the value of craft is acknowledged as a form of intangible cultural heritage, and the RICHES report asks for its preservation and promotion. In addition, it points to the role of heritage resources in creating value for the European economy, contributing to skills development and economic growth. Moreover, this report concludes that collaborations and partnerships are essential for moving from what are often small-scale or individual craft practices to initiatives with a wider and more sustainable scope, as the Digital Platforms for the Crafts report, illustrates. Moreover, partnerships and craft collectives can benefit individual makers who cannot set up and sustain individual micro-businesses. As can be evidenced by Petiot and Braunstein Kriegel’s conclusion and Digital Platforms for the Crafts, such forms of association and partnership should be supported, particularly in areas with strong craft traditions, from the UK to Jamaica, from Myanmar to China, where the economic standing of makers can be strengthened through a combination of traditional crafting methods, digital crafting, fabrication, digital platforms and technology. Collaboration and partnership can have a positive effect on the local economy, now more than ever if we are to survive future pandemics and the present climate crisis, in a brave new world of global cooperation.

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In the 1990s, the British artist Keith Piper was already very well aware of the newer media of interactive CD-ROMs and how the strong content of his art could match the behaviours afforded by the forms of interactive media. The theorist Kobena Mercer was able at that time to make those form and content connections, via a cultural studies lens, in order to encompass the issues of embodiment, power, race and sexuality in Piper’s work. Gilane Tawadros, then director of the Institute of International Visual Arts in London, also made further connections between technologies of fine art, popular culture and commercial communication, to celebrate around fifteen years of Piper’s work in the form of a touring exhibition and catalogue:

Through interactivity Piper has been able to extend what Mercer has defined here as an ‘ethics of answerability integral to the call-and-response dialogue that enacts his political commitment’. An apparent paradox of the cultural impact of new technologies is that even as the need for physical interaction is diminished … so new intimacies of communication and representation are released.

— (Tawadros and Chandler 1997: 5)

The Institute of International Visual Arts (inIVA) had a gallery, but also acted as an arts agency, commissioned early net art for their website, had an archive, did education work and publishing including education packs for schools. Piper the artist, Mercer the theorist and Tawadros the curator were not new media specialists, but dealt with the demands of many different contemporary art forms and politics as they arose, even if that meant changing the ways in which they worked.

Over twenty years later, curator Daniel Birnbaum was still finding that new media, such as virtual reality and augmented reality, challenged not only the content of museums but also the form of the museum structure and systems: ‘But where would this kind of work sit in the museum? … There are elements in these mediums that break up the structures of existing institutions’ (in [Szántó 2020](#b-9781474207935-002-0000412): 199). Exactly where the work “sits” can trouble visual art museums and galleries who have the rhetoric of dealing with a wide range of art forms, but might find some art forms more compliant than others. Of the twenty-eight curator dialogues in András Szántó’s book on *The Future of the Museum*, only two mention new media art rather than new media as an educational or distribution tool.

This article therefore aims to examine a range of museums and galleries in relation to new media art, not in terms of traditional institutional critique or a history of institutions, but rather in trying to trace the connections between institutions, disciplines, departments, roles and ideas, which go together to make systems of production, distribution and historicization.

To start with a brief working definition of new media art, as discussed in the book *Rethinking Curating*, it was not always the specific media that necessitated a change in the way in which the art was curated, but “behaviors” ([Graham and Cook 2010](#b-9781474207935-002-0000288)). Steve Dietz in [1999](#b-9781474207935-002-0000216) identified three characteristics of net art: connectivity, computability and interactivity. Each behaviour, when applied to new media art in general, can be related to different art histories, ranging from installation art or performance art to video. Connectivity, for example, might be familiar to curators or historians of live art, or 1960s conceptual art including mail art. Considering “computability”, the generative, evolving and algorithmic nature of computer software is sometimes difficult for art historians to differentiate from the instruction sets of conceptual art, but the art historical emphasis on understanding materials and processes from gouache to bronze casting should offer useful tools for this. It is, perhaps, the third behaviour of “interaction” which seems to present the most fundamental problems for collecting ([Graham 2007](#b-9781474207935-002-0000247), [2014](#b-9781474207935-002-0000261), [2022a](#b-9781474207935-002-0000270)). This article therefore uses a broad working definition of “new media art” as artwork that is electronic and shows Dietz’s three characteristics either individually or in combination. Rather than using traditional media-specific academic or museological terms, this choice reflects the experience of curators who found that the rethinking necessary was not around digital/analogue differentiation, but around these behaviours.

Starting with some examples of new media’s particular relationship to taxonomies and data, the article goes on to examine the connections between production, exhibition and collection, because although museums are defined by their historicizing collection, both museums and galleries are, like inIVA, making very varied connections with strategies other than simply exhibiting. The examples given here are primarily from my direct experience, and hence often from the UK in the past twenty-five years, rather than only informed by recent pandemic “digital panic”. They aim, therefore, towards providing positive ways in which new media art might be given comfortable international places to sit in the longer term.

## Media-Specific Art Organizations and Histories?

Artist Lu Yang and theorist Marina Vishmidt are both concerned not with material specificity but with non-material systems, whether conceptual systems of artistic ideas, or institutional systems of exhibition and collection.

I am not a new media artist, nor a post-internet one … I … include technology in my work if it enhances and fits with my ideas.

— (Lu Yang in [Cerini 2018](#b-9781474207935-002-0000177))

The economics and temporality of net art, software art, database art or any art process that lives online and is formulated through code, presents a distinctive operating environment for the curator of this ‘immateriality’. This sphere of operations lends itself to a more distributed topography of decision-making and evaluation (quick and painless dissemination of work, participatory features, time/space collapse).

— ([Vishmidt 2006](#b-9781474207935-002-0000439): 45)

Lu Yang challenges the notions of material specificity by questioning the traditional separation of art and technological media. Yang, who studied at the China Academy of Art, uses all necessary media, from augmented reality to giant printed fabric kites. Gender lines are also crossed with her superhero computer-animated *Uterus Man*—a game that uses a conventional video game style and combat structure but very different content in the form of weapons that can change the gender of enemies or lay them low with “ovum light waves”. At first sight, the artwork’s material form appears to be like an ordinary video game kiosk ([Figure 2.1](#b-9781474207935-002-0000020)). Therefore, some reviewers place it in the category of commercial games such as *Grand Theft Auto*, despite the very obviously different content and intent. Reviewers from the Western art press often tend to focus on the “problem” of her choice of digital materials and processes, which are generally associated with popular culture or commercial design. Western culture’s definition of fine art is built on a hierarchical structure that deliberately omits design or craft, and so the cross-disciplinary manifestations of new media tend to affect critical response and hence historicization ([Gere 2006](#b-9781474207935-002-0000240)).

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Many curators are working in less media-specific ways in order to match the methods of emerging artists. Ali Eisa, Public Programme Manager at Autograph gallery in London, acknowledged that although the gallery still has a focus on photography and film, the younger artists they show are willing to use any media necessary, including sculpture, found objects and research methods. At the Imperial War Museum in London, curators described their exhibitions and their collections policy as “media agnostic” ([Graham and O’Hara 2022](#b-9781474207935-002-0000291): 36). For museums, the history of what gets collected is of obvious importance here; photography, for example, can be seen as facing similar issues of acceptance as art, reproducibility, photography as document and perceived problems of preservation ([Moschovi 2020](#b-9781474207935-002-0000338)).

As Marina Vishmidt points out ([2006](#b-9781474207935-002-0000439)), the much discussed “immateriality” of new media art is questionable, because some materiality is involved, and the systems are highly identifiable. The fear of unknown structures of “immateriality” can present a new challenge to museum curators, but Vishmidt and others have identified how new media systems can actually work to improve collection and historicization in the longer term ([Graham 2022a](#b-9781474207935-002-0000270)). In relation to these advantages, Boris Groys states that “artworks as specific material objects—as art bodies, so to speak—are perishable. But this cannot be said about them as publicly accessible, visible forms. … Thus, the individual form of an artwork insofar as it is inscribed in the archives of art history remains intact—only marginally affected by material flux, if at all”. It is important to acknowledge how much new media art has been informed by other art forms in relation to rethinking systems of historicization. After all, any artwork involving processes, systems, interaction, low-status people or low-status materials has faced similar difficulties in being “inscribed in the archives of art history” ([Groys 2013](#b-9781474207935-002-0000294)).

One history which new media art can also call upon is the history of technology, and the lack of awareness of this can be a serious disadvantage for those seeking to historicize new media art, but the problem is not an insoluble one. Above all, histories of new media art have been cross-disciplinary rather than purely technological and hence can draw from, for example, modes of documentation from music and sound art in the form of a “score”, or notions of audience from public art. The Victoria and Albert Museum (V&A) in London can draw strength from design-based notions of versioning, prototyping and mass production. If parallels are considered with performance art, then the debates around collecting documentation in relation to live events are well rehearsed: Rudolf Frieling, for example, describes the performativity of collected works every time they are displayed ([Shannon 2014](#b-9781474207935-002-0000387); [Frieling 2014](#b-9781474207935-002-0000231)). For new media cultures, therefore, such exclusions can be viewed as either a problem or a possibility for change in rigid categories or curatorial systems ([Graham 2007](#b-9781474207935-002-0000247), [2009](#b-9781474207935-002-0000253)).

## Databases, Taxonomies, Histories

For some years now new media technologies such as database software connected to the internet have been used to make documentation of museum collections more “portable”, as Birnbaum would have it (in [Szántó 2020](#b-9781474207935-002-0000412): 199). Many museums, even before a global pandemic forced a consideration of this, saw the potential for being less intimidating and more flexible, by allowing audiences not only to search collections databases, but also to “tag” works and select their own sub-collections. Walker Art Center in Minneapolis had an early example of this affordance, and, more recently, Tate has integrated their archive database with the collections database into “Art and Artists” so now website users can not only select artworks but also research their contexts.

New Media artists have been using the same technologies for their art, for example Thomson and Craighead’s 2002 work *Short Films about Flying #1*, which gathers webcam footage from websites. Ironically, a major problem for historians trying to find new media art in museum collections is the lack of a widely established taxonomy to inform database field contents. For example, the Arts Council Collection in the UK includes four relevant categories on medium: Film and Audio Visual, Mixed Media, Installation, and Multiple. Its collection includes *Short Films about Flying #1*, which rather strangely has the “material description: computer game”. In practice, what this means for online databases of museum collections is that new media art can be difficult to find, as the widely used Dublin Core is very minimal on descriptors related to new media. Some databases, including that of Tate, simply do not use such terms as “new media”, “digital” or “electronic” at all in their browsable categories. Where “new media” is used, sometimes this can mean dominantly or only video art, as is the case with the Pompidou Centre, FRAC Nouvelle-Aquitaine or the National Taiwan Museum of Fine Arts. Some institutions, including the Queensland Art Gallery, prefer the term “electronic media”, where that includes works by John Baldessari. If the media categories fail to help those searching for new media art, then it is also difficult to fall back on searching by name, unless of course you are already familiar with early career artists rather than household names. In general, it could be argued that the sublime quantity of material in online databases is rather wasted if it is too difficult to find and that the problem here is one of the categories simply not fitting new media art ([Graham 2022a](#b-9781474207935-002-0000270)). Some researchers have suggested that a solution to this slow stagnation of collecting could be to use an Open Archival Information System (OAIS) model, which involves several parties in documenting the work: the producer/maker of the heritage, the consumer/user and their intermediary, the custodian of the material or heritage institute ([Van der Graaf and Nauta 2010](#b-9781474207935-002-0000427): 8.4).

In line with this solution of more open systems, the website runme.org is a repository of software art, which has very few existing subcategories; rather, those who submit artworks and those who use the site have developed keywords. The most frequently used keywords become central to the database. These “folksonomies” have been developed by many users rather than by individuals or small groups of experts. The 2012 artwork *Naked on Pluto*, for example, by Aymeric Mansoux, Marloes de Valk and Dave Griffiths, has the self-assigned category of “social software” and the keywords social, lisp, Facebook, ascii, Twitter, propaganda, human, criticism, apocalyptic, surveillance, open\_source, friendly, community, anachronistic, story, multiuser, free\_software, capitalism and 1980s. The site is very useful for finding behaviours such as interactivity as well as content, including witty classifications, such as “Best Grant Hoover” or “Jodi plagiarism” ([Goriunova 2012](#b-9781474207935-002-0000237): 73–80).

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When Altshuler refers to the categories of eBay in relation to “collectibles” ([2009](#b-9781474207935-002-0000150): 38), this might cause museum curators to bridle at the relevance of online shopping. However, oddly enough, these commercial data systems of distribution, buying and selling have strong parallels with the art world systems of touring, accessioning and de-accessioning, with the difference, of course, lying in what is collectable and how the works are documented or exhibited.

## Production, Exhibition, Collection?

The trouble with art histories is that they dominantly concern artworks and artists rather than how works are produced, exhibited and collected. For new media art, this can be a faulty connection in how these areas of practice can lead to historicization. Understanding the connections between the practices is important for new media, because, crucially, the means of production are the same set of media as the means of distribution. For example, TAGallery, which CONT3XT.NET ran from 2007 to 2010 and which “will be maintained as long as Delicious.com allows it”, was a gallery run as a collection of tags and links. Each exhibition, with a named curator, was simply a collection of links to online works by named artists and a title. Here new media are calling into question, as it often does, not only what actually defines an exhibition, but also how it was produced, and how long it will be maintained ([CONT3XT.NET 2007b](#b-9781474207935-002-0000194), see also [2007a](#b-9781474207935-002-0000188)).

## Production

Concerning production, then, for museums this often means commissioning. However, when new media are involved, then this can mean a difference in the way in which curators work. When Benjamin Weil was Curator of Media Arts at the San Francisco Museum of Modern Art (SFMOMA), he noted that the kind of research and development needed for new art and new media art, in particular, demanded commissioning, and a particular kind of commissioning if this was to lead to collection. When he commissioned Christian Marclay to make *Video Quartet*, the artist named Weil “executive producer” on the credits. This role of producer is certainly a more hands-on and practical approach than might be expected and could be particularly suited to new media art (Benjamin Weil quoted in [Graham 2002a](#b-9781474207935-002-0000243)). Commissions do not, of course, always make it into a collection. There is always an element of risk, which was discussed as a prime factor at the “Commissioning and Collecting Variable Media” symposium ([CRUMB and CAS 2010](#b-9781474207935-002-0000197)). This led to discussion of other modes of production that might be familiar to those working with new media—such as that of the “laboratory” mode. There are many good examples of new media labs, for example Eyebeam in New York, that have excellent “producer” modes of working which fully take account of processes, failures and versioning, but fewer examples of where this leads to collections ([Graham 2014](#b-9781474207935-002-0000261), [2022b](#b-9781474207935-002-0000276); [Graham and Cook 2010](#b-9781474207935-002-0000288); [Moss 2008](#b-9781474207935-002-0000341)).

For production in relation to galleries, then, as the examples of inIVA and Vivid in this article show, production often is well integrated into exhibition forms. Museums too are changing in relation to ideas of production. Much of this has been informed by the Critical Making movement, which seeks to question critical hierarchies of art and design by critiquing the systems of commercial production and distribution ([Graham and O’Hara 2022](#b-9781474207935-002-0000291); [Hertz 2012](#b-9781474207935-002-0000309)). As Mugendi K. M’Rithaa points out, the manufacturing base of a country is inextricably linked to all kinds of systems of making, but does not prevent good low-tech ideas such as the passenger drone from developing in Africa. “The Maker movement in Afrika has the potential to foster a paradigm shift wherein the next generation of makers adopt a decidedly *prosumer* ethos” ([M’Rithaa 2019](#b-9781474207935-002-0000343): 29). The boundaries between producer and consumer, between artist and participant, are becoming productively blurred, and these hacked systems are joyfully different to bland standard “globalisation” ([Bradbury and O’Hara 2019](#b-9781474207935-002-0000159)). Forms of production, including participatory forms such as open-source software development, therefore sit at an important intersection of traditional hierarchies of art value, and hence historicization ([Graham 2022b](#b-9781474207935-002-0000276); [Smith 2011](#b-9781474207935-002-0000393)).

## Exhibition—Online and Offline

Concerning exhibition forms, one of the most significant differences between new media art and other kinds of art is that the same set of new media are used both for art itself and for distribution/exhibition. There is a great deal of literature which deals with the significant cultural issues concerning the digitization of objects, museums as repositories of information and what this means for modes of display and interpretation ([Henning 2007](#b-9781474207935-002-0000297): 41; [Noordegraaf 2004](#b-9781474207935-002-0000355); [Parry 2010](#b-9781474207935-002-0000358)). Much of the debate revolves around the tension between the seductive allure of interactive technology’s capacity to engage potentially new and bigger audiences balanced against concerns over access, postcolonial power structures and loss of unique objecthood and human contact ([DCMS 2005](#b-9781474207935-002-0000199): 11; [Graham 2022a](#b-9781474207935-002-0000270); [Rellie 2010](#b-9781474207935-002-0000367); [Sarr and Savoy 2018](#b-9781474207935-002-0000382)). While this dominant discourse can be useful for furthering debate on audiences in relation to art, new media art is sometimes in the unusual position of being confused with new media as a museum exhibition or marketing tool ([Graham and Cook 2010](#b-9781474207935-002-0000288): 164ff.).

I will briefly outline some lessons from history concerning modes of exhibition that are particularly appropriate for new media art. Otto Neurath, Paul Otlet and Le Corbusier, for example, planned a series of museums intended to include wider cultural contexts called “Mundaneums”, and the concept of “open storage display” popular in the 1980s can be seen to relate strongly to the open databases of online collections ([Henning 2007](#b-9781474207935-002-0000297): 28–40). More recently, museums have sought to fit the format of exhibition to the nature of the media used ([Paul 2007](#b-9781474207935-002-0000361)). The exhibition “Mediascape, à pas de Nam June Paik”, for example, at the Nam June Paik Art Center in Seoul, is a permanent exhibition intended to form a “road map of the conceptual space of Paikian mediascape”. The exhibition includes playful elements and works from contemporary artists such as Jodi, and the use of some of Seoul’s huge video walls in public places. The catalogue outlines the chronological development of Paik’s work, but also states “simply ignore this note if you adopt the Paikian ‘random access’ to this catalogue”. The questions for the curator concerning exhibition strategies were very demanding—including whether Paik would have approved of these playful exhibition strategies and the use of the kinds of media that were not available in his time ([Lee and Kim 2011](#b-9781474207935-002-0000335)).

Many other examples of exhibition forms are examined in my article in Volume 3 of this encyclopedia ([Graham forthcoming](#b-9781474207935-002-0000282)). That article explores the particular importance of exhibition forms, where artworks meet audiences, for interactive behaviours of the works. In this article, it is the relation of exhibition to collection, and thence to historicization, which is most pertinent to explore.

## Collection

Concerning new media art collection, if the question “*Why* collect new media art?” is asked, then one answer could be that it is a default option. As curator and artist Domenico Quaranta points out: “In the cache era, accumulating data is like breathing: involuntary and mechanical. We don’t choose what to keep, that is, but what to delete” ([Quaranta 2011](#b-9781474207935-002-0000376): 8). Those in charge of institutional collections obviously have an eye for history as well as for more immediate gratifications, but if they deal with contemporary art at all, they can be including new media art depending on the knowledge and taste of curators or even of national government ideology. In examining collecting internationally, it is noticeable that nations that see themselves as young, forward-looking and technophilic are rather more likely to collect new media art. The National Taiwan Museum of Fine Art in Taichung, for example, has a special category in its collections database for young Taiwanese artists and publishes a lavish catalogue each year of only young artists. Collecting new media art is seen as part of this remit, and the museum as a national collection is actively encouraged by government funding and ideology to do this ([Graham 2012](#b-9781474207935-002-0000259)). Although the funding might be enviable, collecting because of government ideology obviously also has its drawbacks, not least because government ideology changes perhaps even more frequently than art world fashions; therefore, what happens when new media art is no longer “timely” ([Graham and Cook 2010](#b-9781474207935-002-0000288): 285)?

New media art is certainly being collected. For instance, Rafael Lozano-Hemmer’s *Pulse Room*, created in 2006, is a large installation featuring incandescent lightbulbs, voltage controllers, heart-rate sensors, computers and metal sculpture ([Figure 2.3](#b-9781474207935-002-0000060)). Audience members can interact by holding onto metal bars that record their heart rate while a single lightbulb flickers in time with their heart. The next person’s heartbeat bumps the beat onto a grid of many other lightbulbs, and it is possible for people to track their beat until it disappears off the end of the grid of bulbs. The installation is of “variable” dimensions, and a version of the work, *Pulse Park*, is intended for outdoor display in public locations without limits on audience size. The work is therefore difficult to categorize: it is both object-based and immaterial; it is time-based, interactive and highly variable in different installations. Although the artwork might be considered to be not easy to collect, nevertheless Lozano-Hemmer’s work *is* collected and is currently in both institutional and private collections. The work has been exhibited at the 2007 Venice Biennale and as part of a monographic show at Manchester Art Gallery ([Graham 2014](#b-9781474207935-002-0000261)).

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As for what exactly is collected for a relatively immaterial set of media, then museums still understand collection broadly under the headings of object, reproduction or score/performance rights, which hence deeply influence “what is collected”. When examining the actual new media objects that museums have in their collections, it can be interesting from a curator’s point of view to see and handle the solutions that artists themselves come up with. The V&A has a Prints and Drawings Study Room, where, admirably, the public can make appointments to handle works from that collection. Searching the online collection for Casey Reas’s 2010 *Process 18 (Software 3)* comes up with nine separate items in the collection: two CDs containing software, one documentation print signed by the artist, five other digital prints, and a presentation box. There are some aspects of new media art that disrupt museum collection models beyond the general immateriality of conceptual art or performance. First, there is the phenomenon of versioning—common enough in software production where a cycle of improvements is usual, but less so in art. Artists such as Casey Reas, however, are very clear about exactly which version of the software is being considered and which kind of output is obtained from that software ([Graham 2014](#b-9781474207935-002-0000261)). Second, there is a set of socio-economic ethics and systems surrounding certain new media, including open-source production methods, free software, copyleft and multiple authorship, which mean that much work has been done by researchers to integrate details of specific contracts and economics into the consideration of collecting new media art ([Dekker and Somers-Miles 2011](#b-9781474207935-002-0000207)).

Museums with a specific remit to collect new media art are relatively rare, but, where they do exist, they reveal the more subtle variations in what is collected by whom. This code might be materialized or performed in different ways—on a screen or as sound—and the same code might be commercially distributed as a DVD or limited as a small edition. According to Julia Noordegraaf, “there is a tendency in museums to combine elements from various older scripts and turn them into a new, hybrid script” ([2004](#b-9781474207935-002-0000355): 205), and these “hybrid scripts” being developed by museums are therefore seeking to address the tight connections between production, exhibition and collection which are demanded by new media art, as well as redefining what is meant by collection itself.

## Collection, Archive, Documentation, Conservation?

As curator Steve Dietz states, Walker Art Center had “a hybrid Collection that shares similarities with the Permanent Collection, the Study Collection, and the Archives Collection” ([Dietz 2005](#b-9781474207935-002-0000219)). He identifies that an important node for new media art is sitting on an intersection, and so might be found in different areas of the museum, including new media art in the permanent collection, art DVDs in the library or plans in the archive of exhibition correspondence. Museums traditionally are concerned with selection and unique or specific objects. Libraries are traditionally concerned with access and instances of a generally available object. Many digital artworks are easily replicable, however, and artists are more interested in making them accessible than rare. Barbara London has also described how in curating the exhibition “Looking at Music” for the Museum of Modern Art (MoMA) in New York in 2008, she was showing items from the museum collection, from the archive and also items such as vinyl record covers from the library. The exhibition was the first in a series, and “Looking at Music 3.0” in 2011 also took a very broad approach to the wider context of music, including digital cultures ([CRUMB 2009](#b-9781474207935-002-0000195)). All of this serves to highlight that a rethinking of modes of collecting and exhibiting might be necessary if curators are to make the most of the wider context of the work, and the importance of equally wide documentation.

As Suhanya Raffel of M+ Museum in Hong Kong and Sue Breakell foreground:

In East Asia, the digital capacity developed early. We live in a highly digitally alert, digitally active community. As an institution, we need to be much more available to people on that platform. We acquired the work of Young-Hae Chang Heavy Industries, an artist duo based in Seoul, whose practice is entirely expressed in the digital space. Some have questioned this acquisition: ‘How can we even do that, if the work already lives on the Internet, available to everybody?’

— (in [Szántó 2020](#b-9781474207935-002-0000412): 22)

The utopian vision for archives is of a participative, more representative model, which not merely represent the perspective of those in authority but also minority groups and interests.

— ([Breakell 2010](#b-9781474207935-002-0000162))

Thus, the behaviour of participation is one that is linked to the structure of archives themselves and hence to issues of access to collections, for audiences and artists alike. In categorical and collecting terms, many kinds of art seem to fall outside of the most conservative definitions of “art” and thus become “the other”. Large areas of practice where the work of art itself is participatory, community-based or activist are similarly thought to be uncollectable and poorly served by documentation, and hence historicization ([Graham and Cook 2010](#b-9781474207935-002-0000288): 111ff.). Although the conflation of political “others” with art form “others” is to be avoided, there are certain aspects where both the form and the content of an artwork, such as artworks using participatory systems, activist content or working with non-artists, might be deemed to be uncollectable because of layers of otherness. In Dewdney, Dibosa and Walsh’s book on *Post Critical Museology*, they make explicit points about the “‘hard-walled’ separation between the values of collection and those of embodied audience” in relation to the racial origins of audiences, and link this to the need for institutions to be “distributive not contributive” ([2013](#b-9781474207935-002-0000213): 156, 177).

## Archiving and Libraries

Like Breakell, Stuart Comer, Curator of Film at Tate Modern, acknowledges the key tension for strategies that might situate works in an archive rather than a permanent collection. There are hierarchies of power and accessibility involved, so how does the audience then get to access that collection in the form of public display? As Comer says in the brochure for “The Tanks” programme at Tate Modern: “They are not merely performance documentation that can be played back at whim, but rather rely on a specific set of instructions to reanimate both the existing film or video material and the actions that attend it” ([2012](#b-9781474207935-002-0000182): 42).

These instructions are as likely to be in the archive as the collection, and if new media are also often found in the archive, then curators need to be familiar with accessing both systems, and making them accessible to others. At the Nam June Paik Art Center in Seoul, for example, the library is just off the spacious entrance lobby and is literally transparent: screens provide sheltered corners for reading printed matter, using databases or viewing DVDs, but the translucency beckons the user in with the promise of something interesting around the corner. The stacked shelves give an impression of a large quantity of material and there are helpful people to assist the users of this explicitly public library to navigate the relationship between the library, the archive and the large and very physical collection of Paik’s work. It could be argued that libraries, with their concern for accurate metadata, anti-censorship, accessibility and the longevity of information, might offer the perfect home for new media art ([Graham 2014](#b-9781474207935-002-0000261), [2022b](#b-9781474207935-002-0000276)).

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## Documentation

Concerning what kind of documentation gets into archives, and hence what might inform possible future collection, re-exhibition and historicization, again the nature of new media demands a slightly different approach, because an archive might contain both art and its documentation. Rhizome’s ArtBase has at various points in time been described as either an archive or a collection, depending on the levels of conservation and display feasible for various works. Likewise, Pad.ma has elements both of documentation and collection. The actual video works on the website are available to the audience to watch, but anyone can also annotate the video works via open-source software. Lots of information is available about the works and the contexts, and Pad.ma has sought to animate the archive by hosting research fellowships for ‘experiments with video archives’.

Researcher Annet Dekker has usefully identified seven types of documentation which should be useful to curators and historians, including “documentation for recreation in the future” ([2010](#b-9781474207935-002-0000201): 155). This last phrase nicely ties in with other themes in this article—having artworks in collections is rather pointless if the documentation necessary for them to be successfully re-exhibited is missing. As Dekker puts it: “The term ‘Darwinistic Archiving’ was suggested, referring to the survival of the best-documented artworks” ([2010](#b-9781474207935-002-0000201): 6).

It is therefore very useful to be able to combine the information of the archive with the embodied knowledge of the art object. However, when Stuart Comer of Tate Modern talks about an “archive”, then that is the repository where exhibition files containing correspondence, installation photographs, audience studies and budgetary information is kept—information of great value to those wishing to exhibit that work again. Crowdsourced archives do not really replace the painstaking institutional archives, but the latter do have their disadvantages—they might not be available outside the organization, even to scholars. Those working around art collections need to be familiar with both archives of documentation and collections of art, how to extract material from both and how to make them available to audiences. The question remains as to how this might be achievable, but these examples point towards collaboration, the importance of detailed documentation and collaborative connections made between roles, including the roles of audiences.

## Conservation

Concerning conservation of new media art, fortunately many researchers have provided excellent guidelines for how this can be done. A major instrument in the very helpful international Variable Media Initiative is including the useful four options of storage, emulation, migration and reinterpretation, and a written questionnaire, completed by artists and curators, which becomes a record of each collected artwork to help with retaining the key intents and functions in future exhibitions ([Depocas, Ippolito and Jones 2003](#b-9781474207935-002-0000210)). Curator Caitlin Jones reinforces the importance of documentation in an archive and identifies a range of artists’ documentation strategies, including applying the term “thinly specified” to Cory Arcangel’s artwork, in which the artist has loosely defined parameters for the material of the work, welcoming interpretation by the performer or curator ([Jones 2014](#b-9781474207935-002-0000317): 161). If parallels are considered with performance art, then the debates around collecting documentation in relation to live events are well rehearsed. If its importance is acknowledged, then documentation does not need to be expensive, which might form less of an obstacle for artists who might not otherwise be collected.

Above all conservators have stressed that intricate connections between documentation, preservation and exhibition for “new new media” involving software, rather than the old new media of video, which has more established precedents for conservation. Pip Laurenson has examined in detail the kinds of documentation needed for such ephemeral works, including a set of questions for artists identifying the “significant properties” of the artwork. She outlines the importance of exhibition in relation to conservation, whether the artwork is based on an existing metaphor of painting, such as Michael Craig-Martin, or the interactive nature of Rafael Lozano-Hemmer’s work. Laurenson has described the role of the conservator as that of a “broker” of relationships between the staff of institutions and the artists themselves so that collecting can function fully in the long term ([Laurenson 2014](#b-9781474207935-002-0000323)). Many different roles and skills are therefore involved in archives, libraries, documentation and conservation, which need to come together for future histories of new media art.

## Integrated Systems of Production, Exhibiting, Collection and Historicizing?

Glenn [Wharton (2012)](#b-9781474207935-002-0000448) of New York’s MoMA describes *The Museum Life of Nam June Paik* in terms of the effect that the artwork itself has on the roles of all those involved in collections, from audio-visual technicians to registrars. Certain key roles do form important hubs of information, and the connections between them also become more salient. At SFMOMA in 2001, the exhibition “010101: Art in Technological Times” caused changes in the institutional flowchart of work between staff, including who worked with whom, collaborative work and new relationships between curatorial, educational and website staff in particular ([Graham 2002b](#b-9781474207935-002-0000245)). In 2012, Layna White of SFMOMA echoed this change of roles when considering what kinds of information were needed from whom in order to collect new media art, including the roles of conservator, artist and audience ([Baltan Laboratories and Van Abbemuseum 2012](#b-9781474207935-002-0000156)). These factors, if new modes of collection are being considered ([Graham and Cook 2010](#b-9781474207935-002-0000288): 247ff.), all reinforce the importance of roles, and the ability to collaborate between curators and others involved, as Mami Kataoka reiterates: “I formed a new digital team from curators and colleagues from marketing and PR and education, so it instantly became an interdepartmental team, which is quite rare” (in [Szántó 2020](#b-9781474207935-002-0000412): 228).

Louise Shannon of the V&A in London has also pointed out crossovers between archive, collection and many other areas of the museum, including marketing, education and even opening hours. In relation to the “Decode” exhibition in 2010, she traces how education-led events, including the Friday Lates, were related to the commissioning of new media works that allowed for experimenting with various spaces in the museum, including interactive artwork for the John Madejski Garden. Live audience feedback was part of the events, which in turn helped develop elements of the “Decode” exhibition. The exhibition was very popular with audiences, including students and families, and had some highly participatory elements, such as encouraging audiences to recode an animation that Karsten Schmidt created for the exhibition’s marketing campaign. The exhibition tour included some updated versions of artworks at each venue. The exhibition and tour were seen as a good way of thoroughly exploring each artwork in different contexts and led to several new acquisitions for the collection, including Aaron Koblin’s *Flight Patterns* and Casey Reas’s *Process 18* ([Shannon 2014](#b-9781474207935-002-0000387)).

At the Harris Museum and Art Gallery, a smaller regional museum and gallery in Preston, UK, Lindsay Taylor has mapped the relationships needed to both exhibit and collect new media art over a long period of time. Curators, exhibition organizers, collection committees, artists and technicians are all closely involved in the process. Taylor found that a series of exhibitions and educational events helped create both the institutional and audience confidence needed to build a collection of innovative work. Selecting work from a larger exhibition for the collection involved a panel of outside experts and also audience feedback on the exhibited work. The museum decided to acquire Jon Thomson and Alison Craighead’s *The distance travelled through our solar system this year and all the barrels of oil remaining* (2011), which is an elegantly minimalist artwork with the two numbers indicated in the title (taken from live online data sources) projected onto opposite walls. Crucially, the artwork was both the choice of the expert panel and the audience’s “people’s choice”, even though it was perhaps not the most populist or accessible work in the exhibition. It was also perhaps not the easiest to collect because of the live data feeds, but the artists are experienced at this kind of challenge and provided the work with written documentation on updating and acceptable alternative data sources. The artwork has since been exhibited again, which tested the efficacy of the documentation strategies. In addition, the successful acquisition of new media art has led to commissioning new artwork ([Taylor 2014](#b-9781474207935-002-0000421)).

Considering galleries rather than museums, even small regional arts organizations have been enabled to start small collections on low budgets, through their understanding of new media systems, and often also through collaboration. The Northern Gallery of Contemporary Art in Sunderland, UK, for example, had curator Alistair Robinson, who has been able to identify quality artists at an early stage of their career, and hence now has a small but perfectly formed collection of works including Kelly Richardson’s video work, and Daniel Brown’s generative software work *Tropic of Sunderland*, which is a “version” of his artwork commissioned for the specific site of an aquatic centre. The curator can also access a wider network of artworks, which are not collected, but because the gallery has archived information including concerning production, display, copyright and reproduction rights, this knowledge can be used to re-exhibit these works alongside collected works. As co-commissioners of Cory Arcangel’s work in the past, while his work is not technically in the collection, the lead commissioner, Film and Video Umbrella (FVU), did secure reshowing rights to ensure that the work is able to continue to have a life in the public domain; and the gallery’s continued relationship with them ensures in turn that their public have ongoing access to Arcangel’s work without the direct expenditure needed to own a limited edition of it ([Smithson 2019](#b-9781474207935-002-0000395)). This crossover between versioning of artworks; commission and collection; collection and archive, again reflects Steve Dietz’s quote above concerning new media fluidity between museum systems.

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Vivid Projects in Birmingham, UK, founded in 2012, support media arts practice, including exhibiting, and although they are a small team, they have been able to conserve and re-exhibit even mixed-media artworks. For example, the 2016 Vivid exhibition “Reimaging Donald Rodney” was curated by Ian Sergeant, and produced by Yasmeen Baig-Clifford. The late Donald Rodney’s work explored cultural, physical and social identity, and he used video, net art and a laptop-controlled wheelchair in his complex art. This latter work, *Psalms*, was a challenge to show some years later, but by using a network of academic experts including the original collaborators the University of Plymouth, volunteers, artist sketchbooks and archives, they were able to revive the work. There were some new elements, but the “interactional intent” of the artist was retained; the wheelchair had to be able to respond to the presence of gallery audiences on its looping journey ([Sergeant and Baig-Clifford 2016](#b-9781474207935-002-0000385); [Muller 2014](#b-9781474207935-002-0000349)).

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The *economic* systems of art production, exhibition and collection are worth examining at this point, because of their clear effect upon which artists are historicized, by which organizations. My choices of examples from smaller, lower-budget regional organizations are very deliberate. To quote theorist McKenzie Wark on collecting, provenance and new media art:

The information about the artwork is actually the most important thing about it. What establishes the value of the work is that people talk about it, write about it, circulate (unauthorized) pictures of it. The more it circulates, the more value it has. The actual work is a derivative of the value of its simulations.

— ([Wark 2017](#b-9781474207935-002-0000445))

Wark’s view that people talking and writing about an artwork and circulating pictures of it establishes its value is very apt to new media but also risks the propensity for famous mainstream artists to get even more valued, or for Dekker’s “Darwinistic Archiving” to work in less equitable ways. The question of how new media artists can make a living from non-material artworks is still a moot one, despite recent media coverage of artificial intelligence, Bitcoin, blockchain and non-fungible tokens. Felix Stalder has addressed the systems that specifically attach to open-source and free software. Stalder suggests three options that could help to keep both the work and the artist alive: dual licensing, customizing and support. According to Stalder, dual licensing—based on Creative Commons and GPL licensing, which retains a strong emphasis on crediting and moral rights to works—can enable a more flexible sense of ownership ([2010](#b-9781474207935-002-0000403): 84–6). Caitlin Jones, director of Western Front in Vancouver, has explored the objecthood of new media art in relation to exhibiting and collecting and the key art notions of authenticity and authorship. She discusses the example of Rafaël Rozendaal’s strategy of selling websites with unique URL names ([2014](#b-9781474207935-002-0000317): 168). Using examples from private collecting such as Bryce Wolkowitz, Jones finds that the inherent reproducibility of new media does not appear to deter people from buying packaged versions of artworks that are freely available on the internet ([Sollfrank, Stalder and Niederberger 2021](#b-9781474207935-002-0000400)).

When European artists Jodi were questioned about income sources, their reply indicated that public funding was still in the majority, with 10 percent sales, 40 percent fees commissions, etc., 40 percent grants and 10 percent private funding ([Jodi 2010](#b-9781474207935-002-0000311): 144). British artist Emily Mulenga has used the economic strategy of offering free use of her digital emojis *MulengaMojis* for short periods and then requiring payment to keep them longer. The Turkish artist Bager Akbay has fully embraced ersatz and robot authorship by creating “Deniz Yilmaz”, who not only has his own Facebook page with a composite face but who “hand writes” poetry using software and a pen-plotter machine. Akbay (or maybe Yilmaz) sells the results in order to develop “a more affordable classical art environment” ([Yetiskin 2018](#b-9781474207935-002-0000454)).

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What all these examples illuminate is the need for connections not only between roles in museums and galleries, but also between different cultural and educational organizations. The examples also encompass different ends of the collection timeline: exhibiting to collect and exhibiting from a collection. Exhibiting *before* collection might be simply a way of enabling artworks to be seen by buyers, as Caitlin Jones outlined in 2014, or it can be a way of “testing” artworks in gallery contexts and with various audiences before the long-term considerations of collecting in an art institution, as was the case for Lindsay Taylor at the Harris Museum, and Louise Shannon at the V&A.

In my view, new media is most interesting for what it does to the hierarchies of knowledge in the museum, particularly in relation to the division between ‘front and back regions’ of the museum.

— ([Henning 2010](#b-9781474207935-002-0000303): 303)

When Michelle Henning quotes sociologist Erving Goffman’s phrase concerning the traditional divisions and hierarchies between “front and back regions” of the museum, it is precisely these conventional divisions that new media art challenges. The divisions between medium-specific art forms and between art and design are challenged by the immateriality and medium-independent behaviours of various kinds of new media art, in particular behaviours of interactivity and participation. Goffman’s background in sociology also connects strongly to the importance of understanding social systems and the ways in which those systems use technology. The hierarchies between education and the curating departments of museums are particularly sharply delineated, and yet new media also connect these areas, to the point of new media art being confused with new media as a tool for interpreting art.

Recently, there have been indications that museums’ acquisition systems are indeed capable of considering whole exhibitions if the taxonomical structures can be adapted. When the Van Abbemuseum acquired a version of the exhibition “No Ghost Just a Shell”, collecting an exhibition rather than an artwork presented some problems. The exhibition, initiated by artists Philippe Parreno and Pierre Huyghe, included work by other artists, each evolving around the virtual character “Annlee”. In order to be accounted for as an acquisition in the collections-management database as an exhibition rather than a single-authored object, they had to create data record “work sets” for the project as a whole ([Van Saaze 2013](#b-9781474207935-002-0000433): 173). The recognition of the exhibition as a collectable form and the subsequent systemic change bodes well for the future of a more flexible and integrated collecting mindset.

What is also revealed here is the importance of audiences in these connections between exhibitions, collections and historicization. As also explored in my article in Volume 3 ([Graham forthcoming](#b-9781474207935-002-0000282)), if looking at the nature of the art forms where audiences are clearly important to documentation, art that involves performative or participatory aspects emerges. As artist and theorist Olia Lialina has said, many members of the audience might “just have gotten up from their computers” where they might have been busily tagging and favouriting to develop their curatorial skills (2010). However, this growing awareness of crowdsourced documentation, and even crowdsourced curating, can start to falter when it comes to reviews and critical response which are aware of media art histories.

British curator and theorist Morgan Quaintance, for example, has criticized the inability of reviewers to separate the cultural context of popular social media from the reappropriation and criticism of it, for example Amalia Ulman’s work on her body. He noted that there is an “internet anxiety industry” fear, which skews criticism ([Quaintance 2015](#b-9781474207935-002-0000373); [Graham and O’Hara 2022](#b-9781474207935-002-0000291)). Given that in 1980, curator Jack Burnham was struggling with exhibition reviewers because many in the arts “consider themselves ‘humanists’ with strong feelings concerning the encroachments of technology on nature and cultural traditions”, then perhaps action is still needed in order to solve this problem of informed criticism ([1980](#b-9781474207935-002-0000171): 207). Concerning the complex web of how contemporary art might be understood in future histories via what is documented, archived and collected, others have also made connections between the importance of high-quality art criticism for new media art and the establishment of a provenance for collecting. As outlined earlier in this article, the role of the audience in documenting, archiving and criticizing is also very important in historicizing current art. As the sections of this article illustrate, collecting new media art challenges curators, archivists, documenters, artists, educators, historians and audiences.

## Conclusion

When contemporary art curators Biljana Ciric and Sally Lai asked artists and curators to consider what might be important for an *Institution for the Future*, artist Yoko Ono sagely advised to “Make sure the furniture is comfortable”. The curators also stressed the importance of temporality, engagement and collaboration ([Ciric and Lai 2012](#b-9781474207935-002-0000179): 15, 21). This connection between philosophical strategies and the practicalities of exhibitions and audiences chimes with both complex behaviours of new media art, and with Daniel Birnbaum’s earlier quote on finding somewhere for the new art to “sit”.

Within art institutions, there are many different departments to sit in, but those areas are often divided by hierarchies, including “hierarchies of knowledge” ([Henning 2010](#b-9781474207935-002-0000303): 303). The divisions between medium-specific art forms, and between art and design, are challenged by the immateriality and medium-independent behaviours of new media art, in particular by the behaviours of interactivity and participation. Modes of collection are indissolubly linked to modes of display and, in the case of new media’s particular behaviours, highlight a tension between the roles of collector, curator and archivist along different points on a timeline. Modes of collection are strongly linked to the intent behind what is to be collected, by whom and how. Individual artists and curators also need to make a choice in deciding how much of the exhibition-making process to make public. As Alexa Farber identifies, there is a growing demand for, and some response to, an idea of “openness” that works against curators’ tendency to keep exhibition processes behind a velvet curtain until opening night, but fully aligns with new media ideologies of “open source” work processes ([Farber 2007](#b-9781474207935-002-0000225); [Graham 2015](#b-9781474207935-002-0000264)).

An artist’s idea might therefore appear in different versions, using different materials, in different places, at different times, which presents obvious challenges for curators, from labelling and audience strategies to collecting and preservation. It therefore becomes important to be able to define and differentiate various conceptual and institutional systems and perhaps change them so that they fit better with dynamic new media art forms. New media art affects all stages of the art system, from production to dissemination, historicization, conservation and around the cycle again. This article discusses systems rather than discrete materials, with the aim of offering some recent examples of curating that have found solutions in connecting knowledge, roles and ideas, and, therefore, like inIVA, connecting form and content.

For historicization of new media art, a key issue is that, without thorough cross-disciplinary and cross-sector histories from production through conservation, then informed, critical historicization will not be possible for new media art. The curator Jack Burnham, already mentioned, had identified the problem of the humanist/technologist/commerce schism for art reviewers, in 1968, but also criticized the traditional “tools of art scholarship” and “sought out others less respected” ([1968](#b-9781474207935-002-0000168): ix). It has to be acknowledged that some of these tools appropriate for new media art might still be regarded as “less respected” by art historians more than forty years after Burnham’s statement. As explored in this article, certain “behaviours”, such as participation or interaction, might cause new media art to be placed with a firm hand in museum “education” departments, rather than in the collections, archives or libraries from where the sheen of the historical canon might be glimpsed.

Despite the progress of new media art towards integration into museums and galleries being described as more of a rollercoaster than a smooth curve, there are reasons for hope for future museums and galleries ([Stallabrass 2003](#b-9781474207935-002-0000409); [Graham 2009](#b-9781474207935-002-0000253)). Morgan Quaintance, for example, writes for periodicals about new media art with a keen eye for political, economic and institutional systems. His understanding of form and content means that he is able to differentiate between art and commercial intents of new media forms such as video games, even though they may look aesthetically similar. Importantly, this understanding is also reflected in his own curatorial choices for more open systems, such as curating with a committee of two emerging artists and two international artists, opening Cubitt gallery to “free Sunday” exhibitions, and the gleefully retro tactic of curating events around “the photocopier room”. In London, Furtherfield Gallery and Commons have a fine history of “unlocking proprietorial systems”, and also have an eye on historicization by commissioning informed reviews. The art organization inIVA, described in the first section, has dealt with many ups and downs of arts funding concerning gallery spaces, but has always retained its solid corpus of a library and archive, including the display of artworks in the library itself ([Graham and O’Hara 2022](#b-9781474207935-002-0000291)). As curator Marc-Olivier Wahler outlines, some buildings might be fixed, but the “software” of art, skills and people are always evolving, and need to be flexible. “If a museum is only hardware with a software to which it is totally dedicated, then it will be too stiff. It cannot evolve. A post-museum would have to be a museum that is built intentionally as software that can graft onto different platforms. It would not relate only to one building” (in [Szántó 2020](#b-9781474207935-002-0000412): 199). So, although the institutions may be lurching forward (or perhaps just up and down) very slowly, it is the individuals with vision who continue to cross disciplines and sectors.

This article has given examples of sources for different kinds of museum and gallery practice which connect roles and systems in ways that fit new media art, which could be used for developing these histories. However, if these sources are to be brought together for intelligible histories, then theory and practice will need to be integrated, and the systems, methods or modes of both art history and curating will need to understand each other. It could be argued that, since the same media are used for the creation of new media art itself and its documentation, archiving and taxonomy, there already exists a shared system, but there still are understandings to be resolved for a lively future for new media art.

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The unique position of computer arts within the history of modernism can only be fully understood in relation to the central role played by educational institutions. Due to their inherent nature, which required specialist equipment and the technical expertise to operate it, the specific conditions of access became an integral part of its origins. At a time when digital computing was in its infancy, it was educational institutions that provided a major point of access to this large-scale, expensive equipment and personnel.

In the West, research and development for military applications during the Second World War resulted in much computing innovation. Post-war, a boom of government funding and opportunities for research in graphics and animation was created partly as a result of the Space Race, particularly in American universities. In the United Kingdom, a sympathetic governmental framework for a brief time, together with a reorganization of the art education system in the 1960s, led to opportunities predominately in the newly created polytechnics. In Europe and Japan, early activity took place largely in scientific research institutions or university maths departments. Due to their ability to purchase, run and maintain equipment, academic institutions had a formative influence upon the development of the technology itself. This could lead to highly productive working relationships between engineers and artists and activity took place in various centres internationally from the mid-1960s.

Before the onset of user-friendly systems, proprietary software and personal computers, artists learned to write code, often constructed their own hardware and sought to build relationships with scientists and technicians. Additionally, formal and informal networks in art schools organized by practitioners were able to address the challenge of exhibition and dissemination in a field that initially tended to be marginalized from critical review and acceptance by the mainstream art world. Activity at the confluence of computers and art flourished within particular educational institutions largely because it was supported by charismatic and driven individuals, who inspired subsequent generations. These pioneers had a real vision of the arts and sciences coming together for greater understanding and creativity on both sides.

This article focuses on the crucial incubator role played by university art departments, polytechnics and art schools, and those teams within them, in fostering the cross-disciplinary collaborations that laid the groundwork for an art made with computers. As the decades and the technology advanced, this strong foundation helped digital technology to become a significant part of contemporary artistic practice. Due to the extensive nature of the subject a necessary selection is presented here, focusing initially on American and British activities. The research suggests that prior to the 1980s, the majority of new media artists were educated in the West. However, important early pioneers were active in Europe, Japan and South America and these are briefly described here, due to their far-reaching influence. The people and organizations listed here are not the only ones that existed at the time, rather they represent a compilation of activity. The intention is to indicate the variety of work and range of possible approaches to computer use in art schools since the 1960s.

## Team Technology

As historian Jay David Bolter has pointed out, computer technology is team technology: ‘It was born through collective projects at such universities as Pennsylvania, Cambridge, and Harvard, where men and women with varied backgrounds in science and engineering were united by the common vision of creating a logic machine. Since then, every new machine and most significant programs have also been products of a team effort” ([1984](#b-9781474207935-003-0000142): 35).

The history of computer arts education is closely allied with that of the development of computer graphics. In post-war America there was a great interest on the part of the federal government in developing tools for visual representation for science and engineering applications. Various projects were set up during the Cold War, as a response to the launch of Sputnik in 1957 and the subsequent Space Race, to regain America’s technological leadership. The government partnered with and funded universities to do this, through channels such as ARPA (Advanced Research Project Agency) ([Masson 2021](#b-9781474207935-003-0000253)). Rapid results were achieved in the 1960s and 1970s with teams of researchers at places including the Ohio State University, MIT, University of Utah, Cornell, North Carolina and the New York Institute of Technology (NYIT), leading to numerous important hardware developments (such as the invention of the cathode ray tube, CRT) and software innovations. In 1999, a United States government report found, “Part of the reason for the tremendous advances in IT since WWII has been the extraordinary productive interplay of federally funded university research, federal and privately funded industrial research and entrepreneurial companies founded and staffed by people who moved back and forth between universities and industry” ([National Research Council US 1999](#b-9781474207935-003-0000261): vii).

For example, David Evans founded the computer science department at Utah in 1965, partly with an ARPA grant. On the faculty was Ivan Sutherland, who had, at MIT in 1962, produced one of the very first interactive graphics drawing programs—Sketchpad—working under computing pioneer Claude Shannon. Sutherland, Evans and their students from that era developed the foundation of modern computer graphics with personnel including Ed Catmull, James (Jim) Blinn and Alvy Ray Smith. Hardware, equipment and people moved around from various centres and labs, spreading ideas widely. NYIT, one of the most sophisticated graphics studios of the mid-1970s, used equipment by Evans and Sutherland and were prolific in the design of influential paint programs. Ed Emshwiller worked with Alvy Ray Smith to make *Sunstone* (1979), a 3D computer-generated video. Emshwiller went on to set up the Computer Animation Lab at California Institute of the Arts (CalArts), founded by Walt Disney. Several of the people involved with this lab eventually went to George Lucas’s CGI special effects facility at Lucasfilm ([Carlson 2017](#b-9781474207935-003-0000151)).

Within a fine art context, the 1960s were a time of major revolution in the arts and an artistic counterculture emerged which challenged the status quo by encouraging an expanded notion of the art object, reassessed the relationship of artist to audience and acknowledged that the role of art in an industrialized society was changing. Such concepts were first advanced at the Bauhaus, the famous school of design, architecture and applied arts that existed in Germany (1919–33) and combined craft with fine arts. The Bauhaus’s notoriety was based on its avant-garde teaching methods and its attempts to relate creativity and changing concepts of craftsmanship to the demands of modern industrial production ([Naylor 1993](#b-9781474207935-003-0000264)). By the 1960s, boundaries between traditional categories assigned to works of art since the nineteenth century—painting, drawing, sculpture and architecture—were questioned, began to blur and lose some of their distinctions. This helped to engender an environment for possibilities of cross-disciplinary collaboration as well as technologically creative alliances between artist and machine, and artist and audience. Connection with the process of art making and interactivity could now be as equally valued as a finished object. György Kepes, founder of the Center for Advanced Visual Studies at MIT and former teacher at the New Bauhaus in Chicago, stated, “concern with technology today does not simply imply a physical implement, a ‘machine’, mechanical or electronic, but a systematic, disciplined, collaborative approach to a chosen objective. … [T]he medium, in this case technology, is not in itself the message; it becomes a message when it is in a vital dialogue with our most authentic contemporary needs” ([Kepes 1968](#b-9781474207935-003-0000222)).

Nonetheless this was a specialized and rare branch of art; using equipment not originally designed for artistic purposes was a difficult task requiring long hours, dedication and a particular type of mindset. American artist and educator Kent Kirby lamented in 1970, the “narrow and dull” experience offered to students particularly in small liberal arts colleges which, unable to afford the latest equipment, found themselves at a disadvantage compared with the big, well-funded universities. In 1967, only 27 percent of institutions of higher education in the US had computers and most research was done in the sciences by graduate students who were not in art departments ([Kirby 1970](#b-9781474207935-003-0000229)). Despite a strong interest in doing so, there were many who did not work with computers until more widespread use became possible in the 1980s.

Many artists were connected to one another through international, practitioner-led networks and organizations, including the Computer Arts Society (CAS) in the UK, Groupe de Recherche d’Art Visuel (GRAV) in France, and the New Tendencies movement in Zagreb, among others. Through discussions in various published journals, travelling exhibitions, conferences and visiting lectureships a loosely defined, mutually supportive community of computer artists emerged and was particularly dynamic until the mid-1970s.

## Early Activities—America

In the late 1960s in the US there were several forward-looking art departments which developed computer art curriculums independently of each other at around the same time. The Ohio State University, University of Massachusetts (UMass) and the University of New Mexico (UNM) stand out as influential examples of traditionally trained artists inserting themselves into fine art faculties and instigating computer use therein.

At Ohio, Charles Csuri was the first artist in the US to receive governmental funding from the National Science Foundation (1967) to study the role of the computer and software for research and education in the visual arts. Csuri spearheaded the technology with support from the university in terms of both hardware and cooperation; working with mathematicians, programmers and software engineers, he shaped the development of artistic tools, innovative graphics languages, all designed for ease of use, interactive control of imaging and animation capabilities. Over time Csuri’s research activity involved fifteen major projects worth millions of dollars and involved more than forty graduate students in computer science and over fifty students from the field of art ([Csuri and Palazzi 2021](#b-9781474207935-003-0000167)).

The cutting-edge, real-time system in use at Ohio came from technology developed at the NASA space programme project; use of a light pen to draw onto a CRT allowed monitoring of the drawings as they were actually being done ([Dietrich 1986](#b-9781474207935-003-0000172)). *Sine Curve* *Man* and the *Hummingbird* film were two prominent works from 1967 in which Csuri worked with fellow faculty member James Shaffer, from the Department of Mathematics, the latter exhibited at “Cybernetic Serendipity” (1968) and was subsequently purchased by MoMA.

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The exhibition “Interactive Sound & Visual Systems”, at the College of the Arts in 1970, was a challenge by Csuri to current art teaching approaches and an attempt to encourage more interdisciplinary activity at the university. He wrote, “The interaction between art and technology is having an important effect not only upon the types of art objects produced but also upon the changing attitudes about artistic content” ([Csuri and Ohio State University 1970](#b-9781474207935-003-0000164): introduction).

At UMass Robert Mallary developed a computer arts course within the Fine Art Department. Already a successful sculptor with a long-standing interest in art and technology, Mallary was seeking a “fully interactive, synergistic man-machine relationship” when he was engaged to teach sculpture on the faculty ([Mallary 1969](#b-9781474207935-003-0000243)). Mallary could move seamlessly between the two disciplines as he saw art as a process, independent of any particular medium. One of the first to consider how computers could be used to produce forms for sculptural works, he devised his own program—TRAN2, written in 1968 for the IBM system at nearby Amherst College. The first resulting sculpture—*QUAD 1* was exhibited at “Cybernetic Serendipity” and became a series of works exhibited at “New Tendencies 4” (1969).

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Students in his Computer Graphics Workshop wrote programs using batch processing via hand-punched cards. “Frustrations” with this system were described, due to the possibility for many error problems and the huge learning curve required to even begin. Nevertheless, Mallary wrote, “I am convinced it [programming] can play a role in the education of art students by helping them to think and discuss what they are doing more explicitly and analytically” ([Leavitt 1976](#b-9781474207935-003-0000240): 8). From 1978, Mallary developed the Artfile, a collection of graphics programs geared specifically to the requirements of the course, “with the help of talented student programmers recruited from the course” ([Slezak, Abbott and Mallary 1988](#b-9781474207935-003-0000272)). Considered a major creative and educational resource, Artfile streamlined the creative process, allowing users to specify forms such as square, circle or ellipse, make compositions and build these up to create complete artworks.

At UNM the Department of Art became known for a synthesis of studio work, art history and eclectic experimentation, under Charles Mattox, a sound and kinetic sculptor. Mattox, who incorporated machine parts into his sculptural works, was inspired by Siegfried Giedion’s concepts of the fusion of man and machine and “brought a new enthusiasm for the union of art and technology to New Mexico” ([Frank 2020](#b-9781474207935-003-0000194): 17). While teaching sculpture at UNM, Mattox encouraged Richard Williams from the Department of Electrical and Computer Engineering (a principal research contractor for the US Navy) to write a drawing program for the university’s IBM mainframe. This was Art1 (1968), written in Fortran and output to a line printer; its influence spread to other places including Minnesota, California and to the UK, going through several evolutions in a community of open sharing. Work by artists using it was exhibited internationally.

At UNM computer drawing was a special seminar topic in the art department, with guidance by Williams. There was a steep learning curve; most of the students had not come across computers before, as evidenced by this recollection: “You’d drop off your cards; next day you’d pick up [the resulting works] and say, ‘Is that what I did?’ … there was a lot of surprise” ([Frank 2020](#b-9781474207935-003-0000194): 31). These students helped fine-tune the program by suggesting improvements.

In 1969 Katherine Elizabeth Nash, sculpture faculty member at Minneapolis School of Art, visited UNM to learn Art1 ([Nash and Williams 1970](#b-9781474207935-003-0000256)). Subsequently Nash travelled and met members of GRAV in Europe and CAS in England, participating in a number of CAS exhibitions. Keen to distribute Art1 as widely as possible, she sent copies to the University of Iowa computer centre, the University of Puerto Rico and to Brighton Polytechnic in the UK. Back at her home institution, Nash wrote to the dean: “I return to this campus thoroughly convinced that the computer stands today in the same position as the printing press or the weaving machine of medieval days, and our society will experience the same upheaval within the next decade” ([Frank 2020](#b-9781474207935-003-0000194): 107). At Minnesota, Nash collaborated with electrical engineering graduate student Ronald Reichenberger and adapted the program to run on the university’s mainframe—Art2 allowed for more subtle shading effects; subsequent versions followed.

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At Eastern Michigan University Kurt Lauckner of the Mathematics Department collaborated with Gary William Smith, a sculptor in receipt of a grant from the University of Michigan in 1972 for research in computer art. This was the site of the first event of CAS US, the American branch of CAS. “CIRCUIT”, a joint effort among several institutional partners, was a multifaceted exhibition involving many artists from around the US and UK including Csuri, Mallary and others. Alan Sutcliffe, UK Chair of CAS recalled, “The students, mostly having an arts background, were taught the elements of programming and made works in text and graphics” ([Sutcliffe 2009](#b-9781474207935-003-0000278)). Arising from this event *Computer Poems* was published, with a drawing by Smith on the cover and text works from America, England and Europe ([Bailey 1973](#b-9781474207935-003-0000134)).

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## The United Kingdom

British art education of the 1950s was dominated by the concept of Basic Design, stemming from the Bauhaus model, and was of central importance in creating a context for later developments in computer arts education, even influencing the government formalization of art pedagogy. At the Bauhaus a Preliminary Course (referred to as Basic) was implemented in 1919 by its first teacher Johannes Itten (later contributors included Wassily Kandinsky and Paul Klee) ([Itten 1963](#b-9781474207935-003-0000219)).

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In the UK Basic Design curriculums, such as that taught by Victor Pasmore and Richard Hamilton in the Department of Fine Art at King’s College, Newcastle upon Tyne, were a challenge to traditional art practices stemming from Romanticism and were designed to take account of revolutionary developments in modern art. These included abstraction and the importance of creative process, with an emphasis on experimentation. Graduate of the Newcastle course, Roy Ascott, embraced cybernetics as a way to reconcile these differing approaches: the analytical, rational methods as exemplified by Constructivism and the emphasis on intuition and self-expression seen in American Abstract Expressionism. Ascott went on to create the Groundcourse at Ealing Art College in 1961, based on a cybernetic model of behaviour, feedback and process, stressing media dexterity, interdependence, cooperation and adaptability ([Mason 2008](#b-9781474207935-003-0000250)). Ascott has been a radical innovator in new media pedagogy and research, most recently establishing the Planetary Collegium, promoting the integration of art, science, technology and consciousness research internationally in the Centre for Advanced Inquiry in the Interactive Arts (currently based at the University of Plymouth with nodes in China, Italy and Switzerland).

The influence of cybernetics spread from art schools into polytechnics as those who had been students went on to teach. This fed into the radical reform of education that commenced with the Coldstream Report of 1960, instigating a general push by art schools to raise standards, paving the way for BA degree-level fine art courses (introduced in the mid-1970s) and eventually PhDs for artists ([Mason 2008](#b-9781474207935-003-0000250)). By 1967 the government’s recognition of the growing need for more vocational, professional and industrially based courses resulted in a consolidation of non-university higher education into thirty-one polytechnics in England, Wales and Northern Ireland and fourteen central institutions in Scotland ([Department for Education and Science, UK, 1966](#b-9781474207935-003-0000169)). Resources were concentrated into fewer, but larger multidisciplinary complexes, and incorporated many art schools. Now artists had the opportunity to access specialist computer equipment and technical expertise (generally belonging to science or maths departments) for the first time—if not actually under the same roof, then under the same administrative umbrella. This practice was taken up in a limited number of institutions which provided not only education and training, but also career incubation, employment and networking. The three most prominent centres for the development of computer arts were Coventry, Middlesex and Leicester; activity took place elsewhere on a smaller scale. In addition, two stand-alone British art schools pioneered early computer art curriculums—the Slade School of Art (affiliated to the multidisciplinary University College London, part of the University of London) and the Royal College of Art (which remained independent). All such programmes were instigated initially due to the passion of individual tutors who assembled cross-disciplinary teams to implement computers in fine art studio situations.

The first computer animation made in a British art school—*Spinning Gazebo* (1970)—was created at Coventry School of Art (then in the process of becoming Lanchester Polytechnic), where Clive Richards, a technical illustrator and graphic designer, worked with Ron Johnson, Head of Computer Science. By 1971 computer drawing was included in the graphic design courses and a more powerful mainframe acquired, resulting in a number of in-house designed software packages. These included PICTURES (instructions for drawing) and CACTI (Computer-Aided Construction of Technical Illustrations), both used widely throughout the 1970s. Students could work from a relatively short users’ manual and produce something after an hour or less of instruction (obviously much less than that required to learn to write code). *The Computer Picture Book* (1979), a collaboration featuring the work of ten staff and students with contributors from both the art and computer science departments, was a celebration of the innovative computer-generated drawing developed in the school ([Mason 2008](#b-9781474207935-003-0000250)).

Concurrently at Coventry Lanchester, the conceptual art group Art & Language was founded by Terry Atkinson, Mike Baldwin and other tutors within the Fine Art Department. The group, which later included students and American associates, drew upon cybernetics, linguistic philosophy and logics as an attempt to elucidate the theoretical structures that fundamentally articulate the production of art. However, their controversial Art Theory course at Coventry and avant-garde notion of art production was ahead of its time and ultimately proved problematic with the polytechnic authorities, being a less easily identifiable “use” of computer integration into the art curriculum ([Howard 2009](#b-9781474207935-003-0000213)).

At Middlesex Polytechnic (formed from Enfield and Hendon Colleges of Technology, and Hornsey College of Art), it was a programmer who recognized the opportunities for creative computer use and inserted himself into the art community. In the early 1970s John Vince, Lecturer in Data Processing, taught computer languages and technology to students studying a wide variety of courses. Realizing that artists and designers were interested, but recognizing that they did not necessarily want to write algorithms, Vince developed another early package for artists—PICASO (Picture Computer Algorithms Subroutine Orientated). By 1980, PICASO, together with its complementary rendering system PRISM, was being used by over twenty-five academic institutes in the UK. Artists who worked with Vince at Hornsey in the early days include Darrell Viner and Julian Sullivan (both of whom later went to the Slade postgraduate programme discussed below; [Mason 2008](#b-9781474207935-003-0000250)).

At City of Leicester Polytechnic a groundbreaking programme investigating creativity and cognition was initiated by Ernest Edmonds (from a mathematics background) and Stroud Cornock (a sculptor in the Fine Art Department who had previously taught with Roy Ascott). Influenced by cybernetics, they proposed that interaction was a key attribute that would bring with it significant opportunities for participation and for redesignating the role of the artist. The pedagogic and artistic activities at Leicester were widely disseminated and proved to be an important influence on the subsequent generation of artists and practitioners ([Edmonds 2009](#b-9781474207935-003-0000183)).

At the Slade School of Art the pioneering computing curriculum was founded in 1972 by Systems artist Malcolm Hughes as Head of Post-Graduate Studies, who postulated that artists could be scientists too. Stephen Scrivener became the first student at the Slade to do computational work, having discovered that the formalism expounded by Systems art offered great control over image making, and with the computer he further found, “a system that can implement systems” ([Mason 2008](#b-9781474207935-003-0000250): 178). The Department of Experiment was largely driven by artist, self-taught engineer and Head of Department Chris Briscoe, who taught Fortran programming and circuit building, constructed hardware and persuaded management to purchase a mainframe, which he customized. A combination of a high modernist approach to art making and the freedom to experiment with a variety of media including electronics and computing provided a potent mix for the artists who passed through this department until its closure in 1981: Paul Brown, Dominic Boreham, Carole Gray, Nigel Johnson and others. Work by students was published in *Working Information 3* (1978), a limited edition book produced by Jean Spencer, Systems artist and wife of Hughes, and exhibited in “EXP at PCL” (1979) at the Polytechnic of Central London. Several of the Experimental Department’s students went on to pursue PhDs under Edmonds’s supervision at Leicester.

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Leicester was the first institution in the UK to register (Scrivener) and to award (Andrew Stonyer) the degree of PhD to a fine art trained artist, working closely with the Slade. Significantly, the first PhDs for artists were for technically oriented projects, rather than for traditional media. For awarding bodies, new media art appeared to lend itself to a research degree more readily precisely because its technical nature was perceived as having elements which could be examined at a high level. For the educational institutions, this type of work fit in with a research-based culture, proving easier to gain funding for as it could tie in with cross-disciplinary concerns and could be seen to have outcomes other than purely artistic interest (such as drawing programs that could have alternative or additional applications). This demonstrates the very strength of computer arts in the UK and their development within education; arguably such accomplishments at doctoral level would not have been possible outside the collaborative culture of a polytechnic. Edmonds was able to convince the Department of Computer Studies to employ an artist: “Like many others, we were able to follow our art bent under the guise of researching computer graphics” ([Edmonds 2009](#b-9781474207935-003-0000183): 355). Edmonds later set up other important programmes among them the Computer-Human Interface Research Centre (LUTCHI) at Loughborough University and the Creativity and Cognition Research Studios at the University of Technology, Sydney Australia.

At the Royal College of Art (RCA) the first computer to find a (temporary) way into the building for direct use by artists was for the CAS exhibition “Event One”, held over a weekend in March 1969. A loan of Imperial College of Science and Technology’s PDP-7 computer with visual display unit was made possible by George Mallen of CAS, and the RCA’s Patrick Purcell, a senior research fellow in the Design Research Unit (later known as the Department of Design Research (DDR), led by Professor Bruce Archer) ([Mallen 2007](#b-9781474207935-003-0000248)). Mallen joined the DDR in 1971 and in 1977 founded the pioneering Computing Activities Unit, which had computers funded by the Science Research Council (SRC). Over the years, these departments drew upon a wide range of interdisciplinary faculty, visiting tutors, students and research staff. For Brian Reffin Smith, who first studied for an MA in 1975 and then became a research fellow, “This generalist approach, both horizontal and vertical, across and inside disciplines, became for me a model of computer-based activity” ([Smith 2009](#b-9781474207935-003-0000275): 384). Students Colin Emmett and Alan Kitching, enrolled in the early 1970s, travelled to the Atlas Laboratory, Oxfordshire, to use the specialist facilities (most notably the D-Mac digitizer and the SC-4020) to produce animated films, inventing their own software named FROLIC and ANTICS for this purpose ([Mason 2008](#b-9781474207935-003-0000250)).

Smith became College Tutor in Computing in Art and Design, recalled “Students and staff from every school and department presented crazy ideas and asked impossible questions, which of course led to much innovation and fun” ([Smith 2009](#b-9781474207935-003-0000275)). On one occasion Harold Cohen, on a visit to the UK from the Artificial Intelligence Lab at Stanford where he was based, connected with his San Diego studio over the ARPANET (forerunner of the internet), downloaded one of his *AARON* drawings and printed it out, a first in a British art school.

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In 1986 after many machinations and internal politics at senior management level the DDR was closed. Mallen had left in 1983; later he stated, “The computer culture was not entirely welcome in the College” ([Mason 2008](#b-9781474207935-003-0000250): 231). This demonstrated that computer use in art schools could be problematic. Computing at the RCA took a back seat until 1989 when Gillian Crampton Smith moved from St Martins School of Art, where she had set up a one-year postgraduate advanced course in graphic design and computers, and established the RCA’s Computer Related Design Department.

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## Worldwide Computer Arts Activity

In Europe and Japan, artists formed cross-disciplinary collaborations, inspired by an abstract geometric art rooted in principles of Russian Constructivism and the Bauhaus espousal of a new unity between art and technology. An important influence was the German philosopher Max Bense’s theory of Information Aesthetics, declared as “the theoretical basis of visual research using computers” ([Herzogenrath and Nierhoff-Wielk 2007](#b-9781474207935-003-0000210)). Among the first in Germany to make computer art was Frieder Nake at the Technische Hochschule Stuttgart (later the University of Stuttgart), where Bense was professor. From 1963 Nake wrote graphics programs for the Graphomat Z64, the drawing machine built by Konrad Zuse. Bense’s Studiengalerie (part of the general studies academic programme of the university’s Institute of Philosophy) became an important forum of experimental art and held one of the earliest exhibitions of computer art in 1965—*“*Generative Computer-Grafik”, featuring the work of Georg Nees. Nees produced the first doctorate on computer graphics in 1969, supervised by Bense ([Klütsch 2012](#b-9781474207935-003-0000234)). Over a long career, Nake has had great influence as a theoretician, writer, creator and teacher in the domain of digital art, most recently at the University of the Arts, Bremen.

Bense’s influence spread to Japan, where Hiroshi Kawano, a philosopher of analytic aesthetics and semiotics, used the computer to explore the possibilities of programming beauty. Digital filmmaker Yoshiyuki Abe has stated that in the 1960s and 1970s in Japan, “artists had almost no chance to access a computer for producing art works. … IBM Japan in the 1960s was a miraculous exceptional case” ([Abe 2007/8](#b-9781474207935-003-0000124)). Working at Tokyo University’s computer centre, Kawano first published his ideas in 1962 and computer-generated imagery in 1964 in the Japanese technical journal *IBM Review*. His career spanned five decades, covering visual arts, music, poetry, theory and philosophy relating to computing ([Gristwood 2019](#b-9781474207935-003-0000205)).

Influenced by Kawano, in 1966 a group of Tokyo students formed the Computer Technique Group (CTG) at Tama Art University, led by art student Masao Kohmura. Operating as a collective think tank they stated, “By a strategic collaboration with artists, scientists and other creative people from a wide variety of backgrounds, we will deliberate carefully the relationships between human beings and machines, and how we should live in the computer age” ([Oizumi 2007/8](#b-9781474207935-003-0000267)). CTG were internationally networked via the CAS and CAyC in Argentina (see below) and exhibited widely. Later Kohmura became an influential educator at the University of Tsukuba and taught art students programming as an expressive tool, believing that all students should learn programming in practice regardless of their specialities.

Other influences in Europe were cybernetics, kinetics and Concrete Art, such as that of sculptor Nicolas Schöffer in France and the GRAV group, of which Vera Molnár was a founding member. Edmond Couchot, while teaching at the new Fine Arts Department of the experimental University of Vincennes, Paris, collaborated with a group of researchers, computer scientists, painters and musicians in the 1960s. This eventually led to the foundation of a new department—Arts et Technologies de l’Image at University of Paris-VIII, in the early 1980s, the first in France to offer a serious technological curriculum with artistic goals and an education up to PhD level ([Couchot 2018](#b-9781474207935-003-0000159)).

In Italy, from 1965, Auro Lecci produced computer-generated electronic music in Florence with the Studio di Fonologia Musicale, and from 1968 computer art at the IBM Centro Nazionale Universitario di Calcolo Elettronico of the University of Pisa. In 1970 he was invited by Robert Mallary to UMass, where he produced his *Arclink* body of work ([Franke 1973](#b-9781474207935-003-0000197): 232).

In the Netherlands there were several early networks promoting computer-generated art. The Working Group for Computers and Verbal, Visual and Sonal Research (1969–73) at the Institute of Art History, Utrecht University, became a central platform for the exchange of information. Early member Peter Struycken made his first computer drawings in 1969 with programming assistance by physicists Constant A. G. M. Tempelaars and Greta Vermeulen. Other groups include the Foundation Experiments in Art and Technology (1971–6), the Werkgroep Architektuur Komputer, the Institute for Sonology (from 1967) and Studio for Electro-Instrumental Music (from 1969). Two early PhD theses in art history about computer art were defended in 1970 and 1971. The international Interactive Computer Graphics Symposium took place at the Delft University of Technology in 1970. A branch of CAS called CASH (Computer Arts Society Holland) was active in the early 1970s and involved computer scientists Lambert Meertens and Leo Geurt from the Mathematical Center Amsterdam, where they produced computer-generated graphics and music from 1968 ([Fritz 2011](#b-9781474207935-003-0000203)).

Computer art in Spain began in 1968 with Manuel Barbadillo, researching his own painting style in collaboration with the newly opened Centro de Cálculos at the University of Madrid, invited by mathematician and scientist Ernesto García Camarero. From this a seminar for visual arts was developed, Generación Automática de Formas Plásticas, and held its first computer art exhibition in 1970, presenting artworks from the seminars and from other invited artists. Spanish artists involved with these include José Luis Alexanco, Gerardo Delgado and others, some learning to programme in Fortran and others working with a technician as an assistant ([Barbadillo 1970](#b-9781474207935-003-0000137)).

Latin American pioneer Waldemar Cordeiro became involved with the Concrete Art Grupo Ruptura collective in Brazil. Inspired by former Bauhaus student Max Bill, who promoted the concepts of Concrete Art in São Paulo in the 1940s, Grupo Ruptura, in Cordeiro’s words, “helped create a ‘machine language’ appropriate to the communications systems of the urban and industrial society” ([Cordeiro 1971](#b-9781474207935-003-0000157)). From 1969 he produced Brazil’s first computer drawings, in collaboration with the physicist Giorgio Moscati initially at the University of São Paulo. Later he worked at the University of Campinas (Unicamp), where he designed its new Arts Institute, although his involvement with this was cut short due to his premature death. His daughter Analívia Cordeiro continued this interest, building a working relationship with the dean of Unicamp, using the data-processing facility during the night hours. Created for and exhibited at the CAS “Interact” exhibition in Edinburgh *M 3x3* (1973), her videoed work of computer-generated dance was a type of interactive dance-TV system and the first of its kind made in Brazil ([Alvarez 2020](#b-9781474207935-003-0000129)).

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In Argentina, a group of artists (Luis F. Benedit, Antonio Berni and Miguel Ángel Vidal, et al.) interested in systems art associated with CAyC—the Centro de Arte y Comunicación, an arts organization in Buenos Aires—established Grupo de Arte y Cibernetica in 1969. Drawing together a team of programmers, engineers, system analysts and artists, they sought, “a new unity of our art, science and social environment” ([CAyC 1969](#b-9781474207935-003-0000154)). The first to create computer art in Argentina, they used one of the first computers in the country—an IBM located in the Calculus Centre of the ORT School ([Franke 1971](#b-9781474207935-003-0000200)). Work from this group was exhibited internationally, including CAS touring exhibitions, “New Tendencies 5” (1973) and the University of Minnesota (“Art and Computers in Latin America”, 1973).

Abstract artist Manuel Felguerez became a Mexican pioneer of digital art when he started experimenting with geometry and space at the National Autonomous University, Mexico City, at a time when there were only three computers in the country. In the 1970s he moved to the Harvard Laboratory for Computer Graphics on a Guggenheim scholarship. The results of this were published in “The Multiple Space”, which he considered as a kind of “pre-sculpture[,] a system of symbols, an ‘auto-productive’ system, where the author is constantly participating” ([Felguérez 1976](#b-9781474207935-003-0000189)).

## The 1980s and Beyond

The fact that computer art in its early days did not play a major role in the art market meant that much of it was obscured, buried in academia, viewable only in specialist exhibitions or academic journals. However, from the late 1970s, some artists, finding they had transferable skills in animation and special effects desired by advertisers, motion pictures and television, were able to pursue projects in the commercial production sector. In this way computer graphics started to become more publicly visible. In Britain this coincided with a downturn in funding available for universities and polytechnics and through organizations such as the SRC. This was a crossover period with many moving between the public and private sectors, often working on a portfolio of jobs while continuing their individual interests.

System Simulation Limited (SSL), founded in 1971 by Mallen while he was at the RCA to run commercial commissions, heralded this paradigm in the UK. Briscoe and Brown, just out of the Slade, co-founded Digital Pictures as the UK’s first commercial specialist computer animation company in 1980 ([Brown 2009](#b-9781474207935-003-0000145)). The computer graphics arm of Information International Inc. (Triple-I), an American company founded by Ivan Sutherland, filmmaker John Whitney Jr and others was established in 1974 and was involved with many productions including the motion picture *TRON*. Charles Csuri formed Cranston/Csuri Productions Inc. in 1981 to transfer the animation technology created in the lab at the Ohio State University to the commercial world ([Carlson 2017](#b-9781474207935-003-0000151)).

Courses were created at various institutions to teach computer graphics partly in response to this. As the technology continued to develop, more affordable hardware and more easily accessible proprietary software packages became available and artistic use increased.

One of the first to be set up in the UK, the Computer Graphics Studio at Coventry Lanchester in the early 1980s, demonstrated an approach to reconciling the conflicting requirements of educational needs and available finance ([Dyer, Howard and Richards 1987](#b-9781474207935-003-0000177)). Crucial to its success was the support from faculty management with the will to find the money and space for the studio and commitment to the project. The linked Postgraduate Diploma and MA in Electronic Graphics was founded in 1985—the first full-time postgraduate Master of Fine Arts course in computer graphics in Europe—and attracted a mix of artists and designers from the UK and abroad with backgrounds in graphic, product and interior design, fine art, photography and filmmaking ([Mason 2008](#b-9781474207935-003-0000250)).

Middlesex developed into an important centre for computer animation with Vince and his colleagues running fee-paying training courses for industry. Vince recalled, “Designers who had never seen a computer before, in a week were doing [simple] animations” ([Mason 2008](#b-9781474207935-003-0000250): 152). In 1984 in receipt of UK government funding, Middlesex became the National Centre for Computer Aided Art and Design under Brown. It rapidly secured an international reputation for computer animation, interactive media, sonic arts and moving image, creating two of the early master’s courses in computing for art and design. The National Centre for Computer Animation was created at Bournemouth University in 1989 with Vince as Professor of Digital Media and became a leading centre for teaching, research and production in computer animation.

The first Master of Fine Arts programme in Digital Art in the United States was created in 1986 at the School of Visual Arts, New York, under artist Bruce Wands ([Wands 2019](#b-9781474207935-003-0000284)). The Pratt Institute in Brooklyn, New York, created a BFA/MFA programme in Computer Animation and Digital Arts in 1986. Related to these courses, specific textbooks for students of digital art were published; early ones include Isaac Kerlow’s *Computer Graphics for Designers and Artists* (1986) and Joan Truckenbrod’s *Creative Computer Imaging* (1988).

During this time professorships of Digital Art and Digital Art History at universities became more common as did doctoral programmes/PhDs in the history of the subject, building on the work of previous historians such as Frank Popper, Jasia Reichardt, Ruth Leavitt, Patric Prince, Margot Lovejoy, Cynthia Goodman, et al. Into the 1990s, archiving projects were founded to document the history, most notably the Archive of Digital Art (ADA) under Oliver Grau at the University of Krems in Austria, and compArt: Center of Excellence Digital Art at the University of Bremen in Germany, founded by Nake.

By the turn of the century, there were many more new media academic programmes available worldwide. For example, in Hong Kong, the region’s first such institution, the School of Creative Media, City University was founded in 1998 to be a hub of innovation for the creative industries in Hong Kong, Mainland China and abroad. In Singapore a new School of Art, Design and Media at the Nanyang Technology University was created by artist Isaac Kerlow in 2005. This, the first four-year professional art, design and film school to be established in Singapore, had faculty drawn from over twenty countries and runs degree programmes in Digital Animation, Digital Filmmaking, Digital Photography, et al. ([Kerlow 2010](#b-9781474207935-003-0000227)).

## Conclusion

In the 1960s and 1970s, the notion of artists working with computers was unusual. Access to both the necessary equipment as well as the technical expertise required to operate it proved the major hurdle to overcome. This and the financial support necessary while doing so meant that many were involved in academia. Inspired by art historical precedents such as Constructivism, Systems art and a belief in a “human–machine synergy”, pioneering artists had to learn to work within a research-based team environment, building relationships with scientists, using equipment not originally designed for artistic purposes. They learnt to write code, develop software specific to their needs and construct or adapt existing hardware when required. Several innovative developments in the evolution of digital technology and its uses occurred in art schools around the world; however, the notion of computers for use by artists could be controversial within educational institutions.

By the early 1980s, computing technology was radically changing. Institutions worked to build on their strengths by establishing cross-disciplinary teaching initiatives, particularly in response to commercial sector demand for graphics, animation and special effects. Although many continued to write their own code, user-friendly systems and proprietary software were becoming more widely available and affordable. Greater numbers of artists began to use it.

With the advent of the internet and social media new means of dissemination became possible and digital art grew globally. Today, a digitally mediated existence is now standard for most people and computers are ubiquitous in art schools as in the wider world. Working with other disciplines, in teams, is no longer considered radical. Many of the pioneers’ ideas became integrated into mainstream culture. As technology continues to develop at a rapid rate, new creative uses are constantly emerging. Consequently, the complexity of knowledge required has grown exponentially and curriculum development in the best schools is now an ongoing and dynamic process, able to respond promptly to the latest technological advancement ([Wands 2019](#b-9781474207935-003-0000284)). Barriers between so-called high and low art that began to be challenged in the 1960s have all but disappeared in art education. This has caused an increased merging of digital art with contemporary art and the online presence of virtually all aspects of the art world continues to contribute to this integration. The generation coming out of art education now have a wide range of materials, tools and methods at their disposal and generally do not recognize a distinction. The process-driven, interactive, participant-responsive aspects of much early computer art are now a dominant trend in contemporary practice.

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Mathematics, and geometry in particular, has played a part in the visual arts for a very long time. This article will review developments from the nineteenth century to today. Those developments have been extensive and quite revolutionary, both in mathematics and art, and so a full survey is beyond the scope of a single article. The approach, therefore, will be to present an overview with representative examples. Inevitably, the significant artists and mathematicians cannot all be mentioned, but the article will conclude with pointers to further literature that the interested reader can explore in order to look into the subject in more detail. In essence, the article will address the questions of why mathematics matters to art, what relevant innovations took place in recent times and what has the impact been on new media art? Leonardo da Vinci claimed that mathematics was fundamental: “Let no man who is not a Mathematician read the elements of my work” ([Richter 1970](#b-9781474207935-004-0000253): 11). Other artists have supported this view. For example, Paul Cézanne claimed that “The technique of any art consists of a language and a logic” ([Doran 2001](#b-9781474207935-004-0000144): 17), while Alexander Rodchenko suggested that “Art is a branch of mathematics” ([Quilici 1987](#b-9781474207935-004-0000247): 291).

We can see in Leonardo’s art, for example in his use of perspective, that mathematics was fundamental to his creative work. In fact, mathematics has played a significant role in art from well before Leonardo’s time and continues to do so today. Mathematically defined ratios, such as the golden ratio (or golden mean), are known to every art student. Two positive numbers, a and b, are related in the golden ratio if (a+b)/a is the same as a/b (=1.618). For example, a canvas with the dimensions 1 m by 1.618 m has this property.

All new media art implicitly or explicitly depends on mathematics. This article will review the use of, and inspiration from, mathematics in art, particularly during the twentieth century. It will show how such work evolved into new media art practices that either make explicit use of mathematics or of the software systems embodying the extensions of mathematical logic that underpin programming. These art forms are sometimes called “software art” and this topic will be discussed in a later section. In the “Mathematical Revolutions” section, however, the article will go back into the nineteenth century in order to describe some of the key mathematical insights that laid the foundations for all that followed.

## Mathematical Influences

It seems obvious that the branch of mathematics that has been most prominent in the visual arts has been geometry. Although geometric theorems and formal geometry are associated with Euclid and ancient Greece, geometric construction methods must have been used, in architecture at least, in earlier times. Consider, for example, the pyramids. From its own beginnings, Islamic art has been heavily based on geometric figures and pattern making.

In the late nineteenth and early twentieth centuries there were a number of significant mathematical developments that influenced art and these will be outlined in the next section. It is interesting to think about a couple of examples of publications that artists latched onto. A key contribution came from Max Bill with his 1949 paper “Die mathematische Denkweise in der Kunst unserer Zeit” ([Bill 1949](#b-9781474207935-004-0000111)), translated as The Mathematical Approach to Contemporary Art ([Bill 1978](#b-9781474207935-004-0000116)). By 1955 it had been made available in Spanish, French and English as well as German. The quotation below is from the translation in the 1978 book on Bill ([Bill 1978](#b-9781474207935-004-0000116)). Bill’s essay has been widely quoted and influenced many artists, especially those in the Constructivist tradition. In it he briefly surveys the history of mathematics in art and argues strongly against any notion that mathematics was dry and irrelevant to art and feeling. He gives J. S. Bach as a historical example, saying “bach employed mathematical formulas to fashion the raw material known to us as sound into the exquisite harmonies of his sublime fugues … mathematical and theological books stood side by side on the shelves of his library” (ibid.: 110). The mathematics enabled the spiritual music to be composed, one might say. However, in the essay Bill complains about the tight hold that perspective had on visual art for quite some time. His view was, in effect, that this particular construct had such appeal—in that it strongly supported the painting of scenes in terms of how they looked—that it stifled innovation. Imitating the world around us, in terms of how it looked, is only one way of making art. He echoed Malevich: “When the laws of perspective were established, fetters were imposed on the plastic arts. A stall was set up in which the artist was expected to operate” ([Malevich [1919] 2014](#b-9781474207935-004-0000211): 170). Bill argued that as mathematics developed, so should its influence on art. Hence the new mathematical concepts, some of which will be covered in the next section, should be important for the new art. They had freed Western art from the narrow constraints that had largely applied between the Renaissance and the end of the nineteenth century.

While being very positive about early twentieth century masters, such as Piet Mondrian, Bill promoted the idea that contemporary art should embrace the changes in mathematics for its innovations and not just work with the innovations that those masters had offered us. Specifically, Bill referred to the development of non-Euclidian geometry, but there seems no doubt that he intended his ideas to apply to whatever new mathematical ideas might come along. He is unlikely to have known that, as he wrote, work on logic and the foundations of mathematics was leading to the making of computers, to the enormous growth of the importance of algorithms and so to the opportunity to employ software in making art. It is not surprising that he later offered encouragement to Max Bense, who was a key player in the creation of the very early computer-based art movement in Stuttgart ([Monoskop 2021](#b-9781474207935-004-0000232)).

Another influential publication was the 1917 book *On Growth and Form* by D’Arcy Thompson ([Thompson 1917](#b-9781474207935-004-0000283)). It took time before it mattered in art but by the mid-twentieth century it was very influential, particularly in the UK. Thompson was deeply interested in growth patterns and the mathematical regularities that he found in nature: “the harmony of the world is made manifest in Form and Number, and the heart and soul of all the poetry of Natural Philosophy are embodied in the concept of mathematical beauty” (ibid.: 778). *On Growth and Form* described this mathematical beauty in a manner that appealed both to the world of mathematics and the world of visual art, and it included many beautiful illustrations. Herbert Read certainly promoted it and it is clear that Henry Moore was inspired by it and that Naum Gabo had a copy and talked with his friends about it ([Hammer 2014](#b-9781474207935-004-0000181)). Barbara Hepworth knew both those artists well and she must also have been directly, or indirectly, influenced by Thompson. See for example Clare Saxby’s comments on Barbara Hepworth’s drawings of crystalline structures and how they informed her carving: “every graceful curve and contour is formed from straight, interlocking lines that seem to push out into the space beyond them” ([Saxby 2021](#b-9781474207935-004-0000265)). Hepworth also used string in a related way in some of her work.

Perhaps the key point for many of these artists was that Thompson showed how formal structures and procedures gave form to organic shapes. The British artist Richard Hamilton was introduced to the book in the late 1940s and, in 1951, he organized a display about it at the ICA (Institute of Contemporary Arts) in London. As he put it, “It opened my eyes to the idea that the world is as it is because it must follow certain mathematical principles” ([Hammer 2014](#b-9781474207935-004-0000181): 27). Hamilton was influential in the British art schools and Thompson’s work became a standard reference for many British art students.

## Mathematical Revolutions

As suggested above, the nineteenth and early twentieth centuries were full of revolutions in mathematics just as they were in art. This section will briefly review the mathematics. Ever since Euclid’s time, his fifth postulate, the “parallel postulate”, caused concern of one kind or another. One way of putting it is, in two dimensions, given a straight line and a separate point, one and only one line can both pass through that point and be parallel to the first line (never crosses it). Although it might not sound very contentious, many people over many centuries were not convinced that it was obviously true. Attempts to prove it failed again and again. Then, the idea of dropping it came up. What if it was not true? What problems would assuming that it was false make for us? It turned out that all of the rest of geometry worked fine mathematically speaking even if it was not true, as was shown by Nikolai Lobachevskii in 1826 ([Vucinich 1962](#b-9781474207935-004-0000297)). Thus, non-Euclidian geometry was born. This was a major step in that we found that Euclid’s meticulous mathematical reasoning was not as tight as had been assumed. What is more, careful inspection suggested that Euclid made other errors, at least from a modern perspective ([Russell 1937](#b-9781474207935-004-0000256): 404–18). These developments disturbed the belief that basic mathematics was sound and true without question. Euclid was the long-standing basis of that truth, in that he seemed to have shown the basic reliability of geometry in a way that most people did not question. If geometry need not be Euclidian, how about arithmetic? Was it possible that even arithmetic could be different and that the arithmetic that so much engineering and science was based on could be different, even wrong? Hence, the foundations, or philosophy, of mathematics became of great interest and this led to very important mathematical debates and changes.

Another development in geometry was also important. Projective geometry was very familiar to artists through perspective, in which lines are extended (projected) to meet at “vanishing points”, but it had not received all that much attention in mathematics until the nineteenth century ([Russell 1937](#b-9781474207935-004-0000256): 381–92). In the basic form of projective geometry, the key elements are points and lines, rather than distances. The lines do not have a length, or ends, and so can be “projected” to points at infinity. In fact, “a point at infinity” can have a meaning here as any artist using perspective knows well: a vanishing point. The issue of infinity is important mathematically, but for the moment we can just think of it as meaning that any line can be extended as far as we like.

It was important to mathematicians that these developments in geometry were not based primarily on figures or diagrams, but on the symbolic constructions of algebra. That way, the reasoning used would be clear and explicit. This algebraic approach highlighted the fact that only dealing in two or three dimensions was an arbitrary point of view. Why not four dimensions, or five, or an unspecified, *n*, dimension? For example, Bernhard Riemann gave a lecture in which he proposed four-dimensional geometry in 1854 ([Lucibella 2013](#b-9781474207935-004-0000206)). During the latter part of the nineteenth century the popular interest in more dimensions, particularly the fourth dimension, grew and it is most interesting that at the same time that Einstein employed these ideas in his development of relativity artists used them in Cubism. It has not been uncommon to argue that Picasso was influenced by Einstein in this respect but there is no real evidence to confirm this ([Aczel 2007](#b-9781474207935-004-0000090): 71–80). However, these mathematical developments were certainly in the air and we can assume that there was some connection between the opening up of art in this way and the opening up of geometry.

These developments in geometry were very significant for art because the solid Euclidian view, with us for so long, had been abandoned. The very material of plastic art was now to be understood in a new way and many artists thought in new ways about the construction of their works. No longer did the Euclidian view represent how we represented the world. Cubism, in particular, introduced us to another way of seeing that world.

As mentioned above, these mathematical developments posed questions to mathematicians and philosophers beyond geometry, questions about the very foundations of mathematics itself, which was the foundation of so much of life, from finance to technology. Put simply, if Euclidian geometry, which had been solid for 2,000 years, was no longer to be trusted, how about arithmetic? Could we be sure that 2+3=5? These concerns led to what became the most important development of all in mathematical thinking in the twentieth century. Gottlob Frege was an important investigator into the foundations of arithmetic and his work was much admired by Bertrand Russell, who also conducted significant work on the topic. But in 1902 Russell sent Frege a short letter in which he showed that the foundation of arithmetic that Frege was soon to publish had a fatal flaw ([Russell 1902](#b-9781474207935-004-0000259)). As Peter Nidditch put it in his book on the history of logic: “Black clouds came up in the sky and the earth was made dark. Men of mathematics were put in doubt, fearing to see the downfall and destruction of one of the most beautiful theories of mathematics” ([1962](#b-9781474207935-004-0000239): 69). What Russell showed was that Frege’s system, providing the foundation of arithmetic, could be used to prove a contradiction. It implied that one thing was both true and false. This is completely unacceptable if we are to trust arithmetic. The point is that if something is both true and false then it turns out that anything whatsoever can be shown to be true, no matter how clearly we “know” it to be false. In terms of arithmetic, this meant that Frege’s system did not provide the foundation for all that is true in arithmetic, as it mixed false arithmetic indiscriminately with the true. Not surprisingly, a vast effort was set in train to try to overcome this problem and restore confidence in mathematics. It is a long story, beyond the scope of a short article, but certain consequences are important for us.

To cut the story short, key developments were that David Hilbert set a number of challenges that, if met, would resolve things ([Detlefsen 1986](#b-9781474207935-004-0000141)). His programme was based on the notion that it should be possible to describe all of mathematics in a precise formal language. For one thing, this would make it possible to explicitly check each step of mathematical reasoning. Hilbert proposed that any formal system, for example one that defined arithmetic, should be both consistent (it not being possible to prove that something is both true and false) and complete (everything that is true is included). What is more, he proposed that it should be possible to prove, in formal terms, that the system had both of these properties: completeness and consistency. There was more, but this simple description is enough for our purposes. On the face of it, Hilbert’s programme does not seem overambitious, although there are several philosophical issues underneath it not covered here. It turned out, however, that the programme was indeed too much to ask for. Kurt Gödel came up with a proof that these conditions could not be met ([Gödel 1931](#b-9781474207935-004-0000172)). He convincingly showed that, even just for arithmetic, we cannot prove that any formal system that defined it is both consistent and complete. This was another major upset to our perception of mathematics, and of rationality itself. Gödel’s theorem caused a flurry of activity and much debate in mathematical circles as well as catching popular attention. This interest and debate continued, into the twentieth century. In lay terms, we might ask “Can we ever trust mathematics again?” A fundamental question, which was also part of Hilbert’s programme to solve, was “Is there a way of checking that any given mathematical statement is actually true (within a finite time)?” It seemed quite a serious question to have in doubt.

Skipping over the many mathematical and philosophical advances that followed Gödel’s key contribution, the really important next step was Alan Turing’s 1937 paper in which he proposed a constructive approach to dealing with these mathematical matters and described what has become known as the Turing Machine, a theoretical model of what became, with his help, the digital computer ([Turing 1937](#b-9781474207935-004-0000286)). This “machine” was universal in that it could be given instructions that would enable it to perform the function that any specially built “machine” could. The Turing Machine is a theoretical model of the programmable computer, driven by algorithms. To quote Jack Copeland, “In 1936, at the age of 23, Turing invented the fundamental logical principles of the modern computer … he had recently been elected a Fellow of King’s College, Cambridge … A few steps from King’s Isaac Newton revolutionized our understanding of the universe. Turing was about to usher in another revolution” ([Copeland 2017](#b-9781474207935-004-0000128): 49). Almost as if it was an aside, he used his methods to show that the above question, “Is there a way of checking that any given mathematical statement is actually true (within a finite time)?”, sadly had the answer “No”. However, the key point, from the perspective of this article, is that the algorithm became centre stage. What was claimed to exist had to be shown by the delivery of an algorithm that would generate it within a finite number of steps, no matter how many those steps might be. Ever since, constructing algorithms has become a major activity within and outside mathematics itself.

The philosophy of mathematics led to the computer. The software that we write to drive these machines is basically in the form of mathematics proposed by Turing. Later, a few particular mathematical inventions will be mentioned that have been notable in art but, as we will see, they have depended on the availability of the computer. It is important to stress that, with or without the computer, geometry remains an important element in new contemporary art. In summary, mathematical revolutions have both paralleled revolutions in art and enabled them.

## Into Twentieth-Century Art

In the early years of the twentieth century, it was not uncommon for artists and writers to be attracted to ideas coming from science. Relativity, the fourth dimension and non-Euclidian geometry were all “in the air”. The innovations in the mathematics of geometry discussed above were fundamental to most of these ideas. It is not always certain that an artist was directly inspired by the mathematics rather than that they connected through more general ideas that were discussed at the time. As already mentioned, Cubism is an interesting and intriguing case. Picasso and Braque certainly explored a new way of representing space in their paintings and it coincided with the interest that Einstein, in particular, generated in the new geometries. Neither direct influence or inspiration can be demonstrated but we must accept some distant connection, even if mathematics had no real part in Cubism. The influence of Cézanne on Cubism is clear enough but the influence of mathematics is uncertain. It did not take long, however, for the link to be pointed out. In 1913, Apollinaire wrote:

Until now, the three dimensions of Euclidean geometry were enough … The new painters have not proposed to be geometers any more than their elders did. But one can say that geometry is to the plastic arts what grammar is to the writer’s art. Today, however, scientists no longer confine themselves to the three dimensions of Euclidean geometry. Painters have been led quite naturally and, so to speak, intuitively, to preoccupy themselves with the new ways of measuring area now possible, which, in the language of the modern studios, are briefly and globally designated by the term *fourth dimension*.

— (1913: 482)

This last statement, that modern studios used the term “fourth dimension”, certainly indicates that the concept was very much in the air even if the technical details of non-Euclidian geometries were not widely understood.

In the early twentieth century in Russia, there were other very important developments in art, partly influenced by Cubism, but unlike the above example from France, there is clear evidence that mathematics had an explicit part to play. Malevich’s Suprematism and the founding of Constructivism were certainly responding to the perceived importance of science and scientific thinking, and the developments in geometry, with the consequential developments in ways of representing space, did influence the art. The following examples illustrate this and, in many ways, point forward to new media art.

Kazimir Malevich, like many Russian artists in the early twentieth century, took a very positive view of science and technology. Evidence about his curriculum design for his students proves the point that he saw science as important to them and that he considered geometry as one of the subjects that should be covered. The exact content of the courses is not clear, but as the quotation from him above, about perspective, shows, he was not advocating a traditional exposition of geometry. Patricia Railing and Olive Whicher have shown how basic ideas from projective geometry, in particular lines without ends, were used in Malevich’s paintings ([Railing 1990](#b-9781474207935-004-0000250)). For example, they showed that when one extends the edge of a rectangle in a painting it would often intersect with another element, such as the corner of a square. Malevich may have rejected perspective, but it seems that he did use the concept of the infinite line.

El Lissitzky, who came under Malevich’s influence when they both taught at Vitebsk, later made quite explicit reference to non-Euclidian geometry. In his 1925 essay he said, “The Euclidean conception of fixed space was destroyed by Lobatschewski, Gauss and Riemann. The impressionists were the first to begin exploding the hereditary notion of perspectival space. The cubist method was more decisive” ([Lissitzky 1925](#b-9781474207935-004-0000200)). Hence, there is no doubt that the new geometric concepts were known in this circle of artists, even down to knowing particular mathematicians that had made the advances. Rodchenko was also explicit in valuing mathematics, as demonstrated by the quotation given earlier in this article: “Art is a branch of mathematics.”

The fourth dimension was also important for De Stijl. Certainly, Theo van Doesburg thought so. Mondrian, however, wanted to stress the two-dimensional reality of the canvas ([Henderson 2020](#b-9781474207935-004-0000187)). Nevertheless, many people (including this author) have attempted to find two-dimensional geometric order in Mondrian’s paintings. These attempts have not been striking in their success, but the English artist Anthony Hill proposed another mathematical way of looking at this work ([Hill 1968](#b-9781474207935-004-0000190)). Very briefly, he suggested that it is interesting to look at the connectivity of the elements of a painting, in topological terms, and to analyse them with graph theory, a branch of abstract mathematics that does not come under the heading of geometry. The details need not detain us, as he made no claim that Mondrian used such methods directly, but it is an interesting application of the kind of abstract mathematics that Hill and other English artists started to use, following Max Bill, for example.

An interesting, but rarely mentioned, initiative was Dimensionism ([Malloy 2018](#b-9781474207935-004-0000217)). The Hungarian poet Charles Sirató wrote the Dimensionist Manifesto in 1936 in which he advocated the embracing of the new physics and non-Euclidian geometry by art. The list of artists who signed it is impressive, including Jean Arp, Alexander Calder, Robert Delaunay, Marcel Duchamp, Wassily Kandinsky, Joan Miró, László Moholy-Nagy, Ben Nicholson, Enrico Prampolini and Sophie Taeuber-Arp.

Anthony Hill, Mary and Kenneth Martin, Adrian Heath and Victor Pasmore formed a loose group in the 1950s working on non-figurative art ([Grieve 2005](#b-9781474207935-004-0000178)). Much of this art was geometric in form but the underlying mathematical ideas were not always from geometry. Hill, for example, was particularly interested in structure and relationships, for which the work of Nicolas Bourbaki was well known. Bourbaki did not, in fact, exist. The name was adopted by a collective of French mathematicians who published under that name. They were intent on providing a rigorous grounding for mathematics based on a number of principles, one of which stressed the importance of structure. The concept of structure was concerned with the relationships between the objects of interest. Those objects were not to be anything to do with the world, but were symbols within the language of mathematics. For example, the integers can be seen as a set of symbols with a structure, order, imposed on them. In popular terminology, Bourbaki generated “new maths”. Amir Aczel has written an entertaining and non-technical story of Bourbaki ([Aczel 2007](#b-9781474207935-004-0000090)). Hill’s interest was in the use of Bourbaki’s work to investigate and invent structures, systems of relationships, that gave underlying form to the artworks. For example, in one case he chose a set of eight points connected together in one particular structure (i.e. with given connections, but no specified physical positioning) and then generated all of the different ways in which that structure could be set out, with each connection shown by either a vertical or horizontal line. This set of variations was then used as the plan of an abstract relief ([Hill 1977](#b-9781474207935-004-0000195)).

A second example from this group is Kenneth Martin, who used, among other forms of mathematics, algorithms in the construction of some of his work. For example, in his Chance Order and then his Chance, Order Change drawings and paintings he would use chance methods to select the end points of lines, round the edges of the painting. The lines had a fixed width but, in certain circumstances, could be expanded to be two or more parallel lines. He executed them in a specified order using such rules as, if a line crosses an existing line then it should be expanded, from then on, to include one extra parallel line ([Martin 1979](#b-9781474207935-004-0000223)). The growth of such a painting is reminiscent of the natural processes described in Thompson’s *On Growth and Form*. In 1968, a few months before Martin began his Chance Order works, Sol Lewitt began his wall drawings, which were also generated from algorithms ([Singer 1984](#b-9781474207935-004-0000270)). In his case, there was a different chance element, in that, although the starting point and direction of each line were determined, the execution itself was not done by Lewitt but could vary slightly depending on the person who drew it. In fact, interestingly, Lewitt presented the instructions as the artwork. That was what people could buy. An executed work was just one instance of the class defined by those instructions. Actually, algorithms had already been used by Vera Molnár to make art. From around 1960 she had been using an “imaginary machine” to make her work. “It is a kind of computer without a computer. As the first cybernetic instruments were too expensive at the time, Vera Molnar following the example of her friend, the musician and composer Michel Philipott, decided not to ‘be a machine’ in the Warholian formula, but work ‘as if’ she was using one” ([Baby 2021](#b-9781474207935-004-0000099)). In fact, during the 1960s some artists did begin to put algorithms into software in order to make art, as will be discussed in the next section.

The Hill/Martins group of artists showed some interest in computers but never explored them specifically. However, they were followed by the Systems Group, some of whom were taught by members of the earlier group. The Systems artists often used mathematical concepts in the construction of their works, and in his introduction to the UK “Systems” exhibition, Stephen Bann provided a full historical context for these artists’ work. He posed the question of what had attracted them to the tradition of Constructivism and answered that the appeal “without any doubt, is the attraction of systematic procedures based on an order which is not necessarily apparent in the final work” ([Bann 1972](#b-9781474207935-004-0000105): 9). Through this group, the use of computers in art was promoted in the UK. In 1967 Jeffrey Steele, who founded the Systems Group, speculated about “The extension of the scope of an idea within the terms of its original proposition by the use of computers, which could thereby both assist and clarify the creative process itself” ([Steele 1967](#b-9781474207935-004-0000278): 65). Then, in 1969, he made a proposal for an “experimental workshop” in the newly established Portsmouth Polytechnic, which in the end was not implemented. However, in 1973, Malcolm Hughes, who was also in the Systems Group, established the Experimental Department at the Slade, London, where he installed a computer for the use of his postgraduate students ([Mason 2008](#b-9781474207935-004-0000226): 171–206). In such ways the connections between the Systems Group and computer artists in the UK began to grow ([Edmonds 2014](#b-9781474207935-004-0000147)). Similar connections had been developing in Germany.

## Software Art

Max Bense worked on mathematical approaches to aesthetics in Stuttgart and his student, Georg Nees, exhibited the first show of computer-generated art, in 1965, and was awarded the first PhD on computer art in 1969. Later in 1965, Nees put on a second exhibition jointly with Frieder Nake. Both had implemented mathematical procedures in software that produced drawings by driving a graph plotter ([Nake 2018](#b-9781474207935-004-0000234)). At around the same time that Nees and Nake were doing this work in Germany, Michael Noll was also making such drawings at Bell Labs in the USA. He showed them in a New York exhibition between the two Stuttgart exhibitions ([Noll 2016](#b-9781474207935-004-0000242)). Computer-based art had begun.

It is important to note that there was a fundamental mathematical basis in this computer-based art. It was not simply that people were implementing mathematics in software. The software itself was, and is, based on mathematics. One of the mathematical revolutions described above was the invention of algorithms to generate unambiguous results. The philosophical problems that had faced mathematicians resulted in Turing’s abstract machine. This was a way of dealing with fundamental mathematical problems that ensured that we could have faith in the solutions. Of course, there is much more to it than can be covered here, but the basic concept is quite easy to see. It is the idea that if we want to generate something, for example the answer to an arithmetic question or a geometric construction, we do it by providing an algorithm that can conclude its work in a finite number of steps. This concept appealed to artists who were inspired by the mathematics of images and drawings because of the precision that it offered, which was the same reason that the mathematicians took to it. Naturally, the big step that had taken place, of making machines that could run these algorithms, meant that to these artists software became a new exciting medium.

The impact of writing software on thinking is important. As the computer-based artist Manfred Mohr put it,

If you write a program, you have to order your thoughts, you have to really crystallize exactly what you want to do. You suddenly see everything in a different light, and in a sense, my whole world turned upside down. If I look nowadays at other people’s artworks with the knowledge I have acquired, I look at everything through a logical eye – my mind-set has changed. It is the process of programming that changed my mind, not the program itself.

— ([Boden and Edmonds 2019](#b-9781474207935-004-0000122): 295)

Or, as the artist Harold Cohen said:

I think perhaps I should try and remember why I got involved in computing in the first place. And I think, at the lowest level, it was because, after twenty years of painting, I thought I didn’t know anything more about image making than I had when I started. And I thought, rightly or wrongly, at that time I thought I saw in computing a way of learning something much more objectively about images and how one goes about making them.

— ([Boden and Edmonds 2019](#b-9781474207935-004-0000122): 284)

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All new media art uses software in some sense but, in the context of this discussion on mathematics in art, the art that is made, completely or in part, by writing algorithms is the art that we can categorize as deriving from mathematics. Such art is sometimes called “software art”. The artists Jean-Pierre Hébert and Roman Verostko proposed the term “algorist” for such artists ([Verostko 2002](#b-9781474207935-004-0000291)). Verostko found the algorithmic approach a powerful addition to his capabilities,

I see my algorist work has grown directly from my past work. And the computer, with my drawing machines, has become a kind of prosthesis for exploring art-making ideas that drove my work. With computing power, I get visual leverage that I never had before. Regardless of what path our art-making ideas follow, this leverage gives us tremendous advantages that were not available before.

— ([Boden and Edmonds 2019](#b-9781474207935-004-0000122): 311)

Software art can also use the mathematics of geometry. A clear example is the work of Manfred Mohr, much of which has been based on cubes of more than three dimensions ([Gassen 1987](#b-9781474207935-004-0000166)). His algorithms might, for example, draw a cube in six-dimensional space and then create a view of it, from some particular position, in two dimensions. The six-dimensional cube is projected onto two dimensions. In this kind of projection, the notion of things getting smaller in the distance is not used, so the rules of perspective do not apply. Although some artists see the software as the art—in the manner of Lewitt’s instructions—to many it is only part of it. Mohr’s work is as much about the physical object produced as about the underlying software. As in the pre-computer art discussed above, the mathematics plays an important part but, mostly, it is only one element of the work. Mohr put it like this:

there are many people who think if they visualize mathematical formulas, that’s art. It might be accidentally a fantastic picture, but you cannot just visualize math and expect it to become an artistic thing, it’s just luck if it works out. You have to come from the visual side; you have to develop some visual ideas. For mathematicians my visual results are largely unexpected, because I do not prove anything mathematically.

— ([Boden and Edmonds 2019](#b-9781474207935-004-0000122): 299)

An interesting phenomenon in new media art has been the return of perspective. Virtual and augmented reality art nearly always uses perspective to create the images used. The joy at overcoming the restrictions of perspective, as seen for example by Malevich and Bill, was perhaps premature. Following all of the mathematical revolutions that have influenced recent art, perspective still dominates in at least one significant area.

## Software-Enabled Mathematical Art

The power of the computer has enabled artists to make use of new mathematical techniques in ways that would have been difficult in the past, if only because of the time and effort that would have been needed. The following paragraphs will illustrate the point.

In 1970 Martin Gardner brought attention to John Conway’s “life” game in his “Mathematical Games” column in *Scientific American* ([Gardner 1970](#b-9781474207935-004-0000161)). The game is played with counters on a board, something like a chessboard, that is assumed to be infinite. It is based on rules for survival, birth and death. The rules are applied to the board in a sequence of steps when a number of things happen. Each counter with four or more neighbours dies (is removed), each empty cell next to exactly three neighbours gives birth (a new counter is placed on it) and each counter with two or three neighbours survives. We are free to define the initial pattern. The game can be seen as a generation game and it is easy to program a computer to run it. The key point to notice is how simple rules can generate complex behaviours. The game is an example of a cellular automata system, where the rules may be quite different to “life”, but the system operates in the same way.

The “life” game, and cellular automata in general, appealed to artists who have often made time-based works using these systems as the underlying model. For example, Paul Brown said,

I remember my own excitement when I read Gardner’s article and my frustration working on large sheets of graph paper with a pencil and eraser as I laboriously recalculated frame after frame. The idea of using a system to create an artwork appealed to my logical mind … Six years later, in 1974, I began to learn how to use computers and quickly recognized a perfect medium for explorations of this kind. In 1977 I began postgraduate studies in the Computer and Experimental Department of the Slade School of Fine Arts at University College, London and was astonished to discover other artists who shared my fascination with logical systems.

— ([Brown 1996](#b-9781474207935-004-0000125))

The second example is the fractal ([Mandelbrot 1982](#b-9781474207935-004-0000220)). As with cellular automata, fractals use simple processes to generate complex results. A fractal is a pattern with never-ending repeats, so that as you zoom in, or out, you forever see the same shape. Think of looking into a mirror with a second mirror behind you: you see an infinitely repeated set of images of yourself. Mathematically, it is quite complicated to define, but this is the basic idea. The mathematics was developed over a long time, but it was brought together, and named, by Benoit Mandelbrot in 1975. His work was illustrated by images that soon caught the eye of computer graphics people and artists. Generating a fractal image by hand can be extremely tedious but is not difficult to do using software. Hence it is another example of mathematics that became interesting to artists who used computers. For example, William Latham made computer-generated drawings using fractals. He said of this work that he did in collaboration with mathematician Stephen Todd,

Fundamentally there was an underlying grammar, and the rules we designed determined the way forms would grow in time. Then our next novel step was to build an evolutionary fruit machine which would take all the numbers, that drive the rules, and randomly change them a little bit and generated hundreds of variant forms. The idea here was that the artist becomes a gardener, interacting with the computer, steering through a vast evolutionary space of possibilities.

— ([Cox 2015](#b-9781474207935-004-0000134))

More generally than these two examples, there is a strong interest in recent art in complex systems and chaos, itself a relatively recent mathematical development. For example, the artists Christa Sommerer and Laurent Mignonneau, who have made computer-based works using such concepts for a long time, described some of their art research in this way:

The aim … is to construct an Internet-based interactive artwork that applies and tests principles of complex-system and origin-of-life theories to the creation of a computer-generated and audience-participatory networked system on the Internet. Complex systems theory is a field of research that studies simple subsystems as they increase in complexity. Such increases in complexity can take place as phase transitions, when particles in a network switch one another on or off to catalyze or inhibit one another’s production.

— ([Sommerer and Mignonneau 2002](#b-9781474207935-004-0000273))

Increasingly, we see press articles about complex computer-based systems, mostly referred to as “AI”, used in making art, even suggesting sometimes that the AI actually is the artist ([Elgammal 2019](#b-9781474207935-004-0000153)). This is a question discussed by Stroud Cornock and this author in 1970 (Cornock and Edmonds 1970); however, it is outside the scope of the current article.

Within our scope is to emphasize the point that beyond the mathematics of software itself, the computer has enabled an impressive growth in the application of mathematical techniques to the making of art. Much of this growth has been in various areas of complex systems in which the core enablers are often quite simple but where the implementation of them has required high levels of computation, levels that have been practically impossible to achieve without the aid of the computer.

## Conclusion

Mathematics has played a significant part in art making for a very long time and recently it has only grown. This article has used a number of examples to illustrate this work and the reader is encouraged to explore further if the topic is interesting. The references that have been given are not always to the primary sources because they are intended to provide helpful leads for further investigation, and sometimes a commentary is more useful than the source. Many of references will lead the reader further into the subject.

The article has emphasized the direct use of mathematics, rather than art that has only been inspired by the subject. Inspiration has been important, and a few examples have been mentioned, but very much more could be said. Lynne Gamwell’s book would be a good place to start if this aspect was interesting ([Gamwell 2016](#b-9781474207935-004-0000158)). Another book with this orientation concentrates on Malevich ([Milner 1996](#b-9781474207935-004-0000229)). The examples covered above have often been of art generally in the constructivist tradition, but that is no surprise as formal construction, for example, is often found there. It so happens that computer-based artists who write code are also inclined to be loosely connected to that tradition. However, as in the past, artists find much use for mathematics in all kinds of artistic traditions.

As Max Bill explained, mathematics is not a dry subject irrelevant to art: it is the cornerstone of a great deal of art making and the inspiration for even more. It is no coincidence that the mathematical revolutions and advances mentioned above went parallel with as many revolutions and advances in art. Bill’s article itself is worth reading in order to understand this point of view more fully.

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Cybernetics is hard to pin down. In his foundational book, *Cybernetics*, Norbert [Wiener (1948)](#b-9781474207935-005-0000364) sketched out a synthesis of digital computing, information theory, control engineering and time-series analysis, psychiatry, brain science and ideas of feedback, to conjure up an interdisciplinary vision that spanned humans, animals and machines. From the 1950s onwards, with something of an explosion in the late 1960s—the heyday of the counterculture—but growing again in the present, artists picked up on not so much the cybernetic vision in its entirety as aspects of it that spoke to them and distinguished it from the old artistic paradigms of painting, sculpture and music. In Britain, Roy Ascott was influential in this movement ([Gere 2002](#b-9781474207935-005-0000168): 92–4, Moore and Shanken, this volume), and his 1968 essay “The Cybernetic Stance” captured many of these themes: feedback and dialogue, a decentring of the artist, artwork and “audience” that goes with that, a surrender of control by the artist as a further aspect of that, inner experience and, overlaying all of these, an emphasis on performance, “not what they are but what they do”. Different artists developed different themes in different ways, and these themes are the skeleton for this article. (On the origins of cybernetic art and “systems aesthetics” in the US, see [Burnham 1968a](#b-9781474207935-005-0000126), b; and [Gere 2006](#b-9781474207935-005-0000171): 124–35; [Penny 1999](#b-9781474207935-005-0000239); [Shanken 2009](#b-9781474207935-005-0000298); [Skrebowski 2008](#b-9781474207935-005-0000303).)

On scope: There is no definitive list of artists and works to refer to, no cybernetic canon, so my examples are drawn largely from a spectrum of artists I have encountered in studying the history of cybernetics more generally ([Pickering 2010](#b-9781474207935-005-0000267); see also, for example, Bianchini and Verhagen 2016; [Broeckmann 2016](#b-9781474207935-005-0000115); [Bulatov 2009](#b-9781474207935-005-0000123); [Burnham 1968b](#b-9781474207935-005-0000131): ch. 8; [Gere 2002](#b-9781474207935-005-0000168); and [Turner 2006](#b-9781474207935-005-0000332)). On topics and themes: Starting from Wiener’s *Cybernetics* would legitimate including all sorts of computer art here (and internet and web art) but the field is just too vast and I have focused on more definitively cybernetic artworks (on net art, see Bosma, this volume). I also omit works relating to information theory and information aesthetics, which are covered elsewhere in this volume. My work in the history of science ([Pickering 1984](#b-9781474207935-005-0000250), [1995](#b-9781474207935-005-0000253)) convinced me that the best way to grasp history is as the open-ended development of major achievements, and that is the pattern followed here. I focus on early exemplars which often bring out cybernetic themes better than later elaborations, though I also talk about them when appropriate.

## Agency Realism

Feedback would be an obvious entry point in examining cybernetic art, but prior to that one finds a concern with agency, performance, behaviour, action, doing things—not with what things are but what they do, as Roy Ascott put it. Norbert Wiener in fact derived the word “cybernetics” from *kybernetes*, the Greek word for steersman, conjuring up the sailor who struggles with changing winds, currents and tides in guiding a ship. This image of a lively world runs through the history of cybernetic art, so we can start with artworks that thematize liveliness. This is not an easy topic to get at in conventional static art forms, but I want to point here to cybernetic works that make it explicit, works of what I call agency realism.

An obvious place to start would be bio-art, which shows us very directly the liveliness and agency of the world by taking living materials as its medium ([Catts and Zurr 2002](#b-9781474207935-005-0000134); [Salter 2015](#b-9781474207935-005-0000292): ch. 2). But perhaps bio-art makes the point too easily. It is no surprise to be shown that organic matter is lively and unpredictable, so it would be more interesting to look for agency elsewhere.

We could start with Chris Welsby’s work in experimental film and video running from the early 1970s to the present, which foregrounds the liveliness of nature in action ([Welsby 2005](#b-9781474207935-005-0000356), [2011](#b-9781474207935-005-0000359); see also [<https://chriswelsby.uk>](https://chriswelsby.uk)). Welsby’s aim has been to turn over the work of filmmaking to nature, thus confronting us directly with the agency of the inanimate world. For example, his film *Seven Days* from 1974 is a time-lapse movie of the Welsh countryside taken over a week of daylight. The film, in effect, shows us the agency of nature twice, in two different registers. Most obviously, it is a visual (and sound) record of changing atmospheric conditions. But its key feature is that the orientation of the camera was controlled not by Welsby but by the sun. The camera tracked the sun through the sky; when the sun was out, the camera pointed at the ground; when clouds obscured the sky, the camera pointed upwards. Here, then, material agency—the elements, the sun, the weather, the rotation of the earth—rather than the artist, created the work, and the work speaks directly to us of the agency of nature rather than that of the human, Welsby, who “made” the film. Likewise, sound art (O’Keeffe, this volume; [Salter 2015](#b-9781474207935-005-0000292): ch. 1) trades on and manipulates sounds found in the environment, much as Welsby has traded visually on the weather.

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Those works show us the agency of nature more or less as found by cameras and microphones, but we could also think of works that somehow contain and produce the non-human performances they show us. Hans Haacke’s early work from the 1960s all falls under the heading of agency realism ([Skrebowski 2008](#b-9781474207935-005-0000303)). *Ice Stick* (1964–6), for example, consisted of a 70-inch copper coil connected to a refrigeration unit, and the key feature of this work was not its appearance but the fact that it did something. It condensed moisture from the air so that when exhibited it became enveloped in a growing and evolving sheath of ice. Later works in this series included grass which would grow during the course of exhibitions. Again, these works show us the lively agency of physical and biological processes.

In Richard Brown’s *Electrochemical Glass* (1997), three electrodes of copper, aluminium and iron were immersed in a conducting fluid between two glass plates and slowly evolved over time as a continuously changing work of art. In a conference description, [Brown (2003)](#b-9781474207935-005-0000121) emphasized the unexpected appearance between April and October 2002 of a striking black “dendrite” climbing up the left-hand side. Like Welsby’s cinema, then, but in a different register, Brown’s work confronts us directly with the liveliness of materials, now in a chemical setting rather than in the wild. At an advanced level of technical sophistication, the artworks of Evelina Domnitch and Dmitry Gelfand again make visible dynamical physical processes. An installation from 2010, for example, *Hydrogeny*, uses a laser scan to make visible intricate and evolving strings of hydrogen bubbles emerging from an array of electrodes ([<www.portablepalace.com>](www.portablepalace.com)).

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Finally under this heading, a talk on generative music by Brian [Eno (1996)](#b-9781474207935-005-0000141) points us towards the agency of machines, rules and algorithms. Eno begins with machines and a piece by Steve Reich from the mid-1960s. In this work two identical tape recorders both playing the same recording of a preacher saying “it’s gonna rain” go slowly out of phase with one another, generating beautiful sounds with no evident connection to the spoken words. Somehow the behaviour of the tape machines generates the music. Eno then moves on to rules, and discusses how the instructions to an ensemble of musicians in Terry Riley’s *In C* (also from the mid-1960s) again serve to generate quite unpredictable performances and sonic events. Now it is as if the rules and instructions generate the music. Eno then moves on to computer algorithms as embedded in his own ambient and generative music. (On generative art, see also [Boden and Edmonds 2009](#b-9781474207935-005-0000110).)

## Emergence and Control

A complication is worth thinking about now. I stressed that cybernetics and cybernetic art have been about agency and performance, but now would be a good place to be more precise. Agency in cybernetics is something unpredictable. It is not a matter of linear cause and effect—I press a button and my car starts; I hit a key and a letter appears on the screen of my laptop. Instead, the sort of agency that has concerned cybernetics is unpredictable, always liable to surprise us, emergent in just that brute sense. Think of the weather on a Welsh hillside in *Seven Days*. You could make a guess about probabilities (it will probably rain; the sun might shine), but the details of rain and sun that constitute Welsby’s film were entirely unpredictable in advance. One could say much the same about Brown’s *Electrochemical Glass* and Domnitch and Gelfand’s *Hydrogeny*—the behaviour of both was quite unpredictable in detail. A vision of the world as a space of emergent agency is central to cybernetic art.

Emergence leads to questions of control. One cannot control in any linear sense an emergent or quasi-emergent system. You can either let such a system go and find out what it will do (Haacke, Welsby, Brown, Domnitch and Gelfand)—let the performance shine through as art. Or you can try, more actively, to get along with it. In an interview, Eno ([2003](#b-9781474207935-005-0000144): 57) credited the cybernetician Stafford Beer for suggesting to him that you can “ride on the dynamics of the system in the direction you want to go. That really became my idea of working method”. This notion of riding the dynamics of emergent systems runs through many of the examples discussed below. The point to stress for the moment is that working with emergent systems and phenomena *decentres* the artist. No longer is the artist imaginable as the sole origin, the master of his or her materials, responsible for and claiming the credit for every detail of a work. Instead the cybernetic artist is more of a midwife, helping the work come into existence rather than creating it de novo.

## Feedback Art

Conventional art is static and unresponsive. Paintings just hang there on the gallery wall, unchanging and indifferent to their surroundings. If the colours tend to fade in bright light, that is just a problem that needs to be addressed. In contrast, in the opening quotation Roy Ascott pointed to the dynamics of feedback, dialogue and interplay as key features of cybernetic art, and these are often thought of as the defining features of cybernetics in general. We can start by examining some artworks that engaged in dialogue and interplay with their non-human environments and then move on to works that engaged in interplay with human participants. (For book-length surveys see Bianchini and Verhagen 2016; [Broeckmann 2016](#b-9781474207935-005-0000115); [Burnham 1968b](#b-9781474207935-005-0000131); see also [Kac 1997](#b-9781474207935-005-0000190).)

Many interactive artworks are descendents of the “tortoises” built in 1948 by the cybernetician W. Grey Walter ([Pickering 2010](#b-9781474207935-005-0000267): ch. 3). Intended as scientific models of the brain, the tortoises were small mobile robots equipped with two sensors: a photocell and a touch sensor. When the photocell detected a light, the tortoise would try to head towards it. When the touch sensor detected an obstacle, the tortoise would move in a back-and-forth pattern, eventually, with luck, getting around it. The tortoise thus interacted with and navigated in crowded environments in a real-time dialogue with lights and objects. Its movements were determined by feedback from its surroundings.

And we should note that just as the works discussed earlier were emergent and unpredictable, so were the motions of the tortoise—Walter remarked that their behaviour surprised and sometimes baffled him. And just as works of agency realism decentre the artist, so the dynamics of the tortoise were also decentred, a joint product of the tortoise’s inner workings and its environment. We could read these robots, then, as little models of a decentred human creator. The tortoise was an early example of work in artificial life (A-Life). [Penny (2009)](#b-9781474207935-005-0000244) reviews A-Life artworks, emphasizing their emergent qualities. We could see A-Life as an artificial counterpart to and forerunner of bio-art (mentioned above).

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In succeeding years, Walter’s tortoises have been prototypes for all sorts of robots built for all sorts of purposes (including brain science and the situated robotics developed by Rodney Brooks at MIT in the 1980s ([Brooks 2002](#b-9781474207935-005-0000118))). The earliest artwork generally (if mistakenly, see below) recognized as cybernetic is Nicolas Schöffer’s *CYSP1* from 1956 ([Broeckmann 2016](#b-9781474207935-005-0000115): 97–100; [Burnham 1968b](#b-9781474207935-005-0000131): 340–41). *CYSP1* (for “Cybernetic Spatiodynamic”) was a mobile sculpture consisting of geometrical elements arranged on a rectangular skeleton, and what distinguished it from earlier kinetic artworks was that, like the tortoises, it was equipped with sensors (in this case, microphones and photoelectric cells) that governed the motions of its parts and of the whole work in response to feedback from the world it found itself in ([Adam Montmartre 2010](#b-9781474207935-005-0000100)). Responsiveness to feedback is what distinguishes this sort of cybernetic art from a broader tradition of kinetic art (on the history of which, see Mason 2011).

The tortoises were social robots. They engaged with their own reflections and with other tortoises in what Walter referred to as their “mirror” and “mating” dances. And this line of social robotics was developed further in the *Colloquy of Mobiles* exhibited by the second-generation cybernetician Gordon Pask and his collaborators at the “Cybernetic Serendipity” exhibition held at the Institute of Contemporary Arts in London in 1968 ([Pickering 2010](#b-9781474207935-005-0000267): ch. 7; for a beautiful re-creation by Paul Pangaro and collaborators, see [Pangaro 2020](#b-9781474207935-005-0000231)). The *Colloquy* consisted of five mobile robots—three designated female and two male—that interacted with one another in, again, a sort of mating dance mediated by sounds and lights. Visitors to the exhibition could interfere with and take part in these dances using mirrors to redirect the robots’ light beams. We can come back to this sort of participation in a moment.

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Now for a variant of the robotic scheme. The tortoise’s brain was assembled from some simple electrical components: valves, capacitors, relays. In more recent robotic iterations these have been updated with silicon chips and computers. But Garnet Hertz’s *Cockroach Controlled Mobile Robot* from 2005 moves in a different direction. As the name suggests the brain of this robot is not electronic but organic—a giant Madagascan cockroach, in fact. The roach runs on a trackball, seeking to evade lights which register approaching obstacles, and thus (when it works) steering the robot through its environment ([Hertz 2005](#b-9781474207935-005-0000183)). In Hertz’s work, the performativity of an electronic brain is replaced by biological liveliness, thus situating the roach-controlled robot in a tradition of “biological computing” ([Pickering 2009](#b-9781474207935-005-0000262)) running from the psychologist B. F. Skinner’s attempts to use pigeons for missile guidance in the Second World War up to various forms of bio-art today ([Pickering forthcoming](#b-9781474207935-005-0000275); [Van Eck and Lamers 2013](#b-9781474207935-005-0000335)).

The examples so far have principally acted on feedback from the inanimate environment, but an important class of interactive robot art centres on interplay and dialogue between machines and humans. Early classics of the genre are recognized to include Edward Ihnatowicz’s *SAM* and *Senster*. *SAM*, the *Sound Activated Mobile*, was exhibited, like Pask’s *Colloquy*, at “Cybernetic Serendipity” in 1968. It consisted in a flexible spine that tracked visitors, controlled by four microphones monitoring ambient sound ([interactivearch 2008](#b-9781474207935-005-0000185)). The *Senster*, first shown in 1970, did much the same, tracking spectators with microphones and radar, but in a much more spectacular fashion—pursuing its target with a 9-foot-high, 15-foot-long flexible neck, swooping on its human prey like a giant insect—or a cross between a giraffe and a dinosaur ([<www.senster.com>](www.senster.com); for a wonderful 2018 re-creation of *Senster*, see [szkieletek Eternia 2018](#b-9781474207935-005-0000301)).

Simon Penny’s *Petit Mal* ([<https://simonpenny.net>](https://simonpenny.net)) from the early 1990s was another mobile robot like the tortoise, and is interesting from several angles (see also Penny, this volume). First, it was deliberately designed to engage with a human “audience” (or, better, “interactors”). Equipped with motion sensors, it moved differently according to the motions around it, spinning and travelling around, hopefully eliciting further movements from its human partners in response, to which *Petit Mal* would then respond in turn, in a dance—a dance of agency ([Pickering 1995](#b-9781474207935-005-0000253))—coupling the robot and its partners together. Second, the body of *Petit Mal* was basically a double pendulum (one carrying the batteries, the other the sensors) mounted on two bicycle wheels—and the key point here is that the oscillations of a double pendulum are chaotic and unpredictable, emergent in practice, just like the actions of the tortoise. *Petit Mal* thus embodied emergence by design and foregrounded it. Penny’s idea was that an unpredictable system is more life-like and more likely to engage a human partner than a predictable and fully reliable machine. Third, it is interesting to note that Penny’s art has fed into his philosophy and reflections on the sort of embodied and enactive cognition displayed by *Petit Mal*, most notably in the book *Making Sense: Cognition, Computing, Art, and Embodiment* ([Penny 2017](#b-9781474207935-005-0000247)). A later iteration of this sort of dynamic and interactive robot art, *Performative Ecologies* by Ruairi Glynn, incorporates a genetic algorithm to explore ways of entraining its audience ([<www.ruairiglynn.co.uk>](www.ruairiglynn.co.uk)).

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Much of Stelarc’s performance art likewise thematizes human/non-human feedback, staged much more intimately than the remote sensing of *Senster* or *Petit Mal*. In many “cyborg” projects from the 1980s to the present he has performed and struggled with robotic appendages attached directly to his body, sometimes animated by his own muscles; sometimes controlled by others elsewhere (stelarc.org/projects.php).

Along similar lines, we could think of the Bodycoder sound system developed since 1994 by Mark and Julie Bokowiec ([<www.juliebokowiec.com>](www.juliebokowiec.com)) in which switches and sensors on Julie’s hands and arms control a complex digital environment, shifting intensities and frequencies, controlling loops and delays, all ultimately deriving from her voice as input ([Wilson-Bokowiec 2012](#b-9781474207935-005-0000367)). In a feedback loop, “there is a kind of live negotiation that goes on between the acoustic voice and the processed. … I sometimes have to listen more intently to the electroacoustic consequences than I do to my own acoustic vocalisation” (ibid.: 7). In an interesting sensory crossover, she describes a novel physical sensation of “grainy resistance” that has emerged in performance, in the absence of any physical input, alongside “moments of acute physical and aural focus that required difficult finite control” in working with Bodycoder ([Wilson-Bokowiec and Bokowiec 2008](#b-9781474207935-005-0000372): 135). Besides the usual aspect of emergence and surprise, this points to Bodycoder as what I refer to below as a technology of the self, in this case an assemblage that elicits transformations in the performer’s senses.

## Adaptive Art

The examples discussed so far centre on rather direct feedback relations in which artworks and audiences remain largely unmodified in their interaction. In contrast, it is interesting to think about adaptive works, in which works and audiences adapt and transform themselves in relation to one another. The prototype for such works, and probably the first explicitly cybernetic artwork, was Gordon Pask’s *Musicolour* machine, on which he began construction in 1952 (four years before Schöffer’s *CYSP1*) while still an undergraduate ([Pask 1971](#b-9781474207935-005-0000233); [Pickering 2010](#b-9781474207935-005-0000267): ch. 7)). *Musicolour* was an electronic device that enabled a live musical performance to control a light show. Importantly, the output of *Musicolour* was emergent in a couple of senses. On the one hand, its circuitry was complicated enough to make it impossible to predict which sounds would bring about which lighting effects. And, at the same time, the parameters of the machine would themselves vary with the details of each performance. Electrical thresholds would move upwards and eventually the machine would cease to respond to repetitive inputs. In this sense, the machine adapted and changed its inner configuration as each performance unfolded, encouraging the human performer to adapt in turn to the machine, finding new musical strategies to keep the light show alive.

Here, then, the feedback relation was not one of (circular) cause and effect, but rather coupled experimental transformations and emergent becomings, a relation that Pask thought of as “conversation”. And Pask was also one of the few people to attempt to theorize the aesthetics of cybernetic artworks. In a discussion of “aesthetically potent environments” he conceptualized them as sites of learning and interpretation that can “respond to a man, engage him in conversation, and adapt [their] characteristics to the prevailing mode of discourse” ([Pask 1971](#b-9781474207935-005-0000233): 77).

*Musicolour* was the model for a whole range of subsequent projects, most notably the Fun Palace in London in the 1960s ([Mathews 2007](#b-9781474207935-005-0000223)). Designed by the architect Cedric Price, the Fun Palace was intended to be a reconfigurable public space amenable to a wide variety of uses. Pask’s contribution was to devise a control system for the building analogous to *Musicolour*, which would both support existing patterns of use and prompt experimentation with new ones. The building and its users would thus engage in a *Musicolour*-like emergent and decentred conversation. In the end, the Fun Palace was never built, but it has been the inspiration for developments in interactive and adaptive architecture up to the present ([Frazer 1995](#b-9781474207935-005-0000157); [Furtado 2008](#b-9781474207935-005-0000160); [Negroponte 1970](#b-9781474207935-005-0000226); [Velikov 2015](#b-9781474207935-005-0000340); see also [Sadler 2005](#b-9781474207935-005-0000289) on the Archigram group).

Andy Gracie’s series of artworks under the heading Hybrid Ecosystems (2001–8) continue the theme of reciprocal adaptation, but in a different register, in which the human participant is replaced by an artificial intelligence system, now in conversation with organic systems: crickets, fish and plants, and bacteria and rice ([Gracie and Rowe 2005](#b-9781474207935-005-0000180); [<www.hostprods.net>](www.hostprods.net)).

## Art as Interface

So far we have looked at lively artworks interacting with their human and non-human environments. Now we can turn to artworks that serve as interfaces *between* lively human and non-human actors (thus echoing Andy Gracie’s work above, but with humans reinstalled in the place of Gracie’s AI). Two of Ursula Damm’s works ([2018](#b-9781474207935-005-0000139)) make connections between humans and flying insects: *Insect Songs* and the *Drosophila* Karaoke Bar ([<http://ursuladamm.de>](http://ursuladamm.de)). In both cases the object is to set up a creative and more or less symmetric connection between the human and insect worlds—swarms of midges and flies respectively. In *Insect Songs*, for example, the musician Christina Meissner played midge-like sounds on her cello to which the midges somehow responded, and their behaviour was then amplified back as sounds and visuals to Meissner, who then responded to that, creating a human–insect feedback loop: “We were thrilled to notice that it was so easy and obvious that humans and midges interfere. In our second concert, it was no longer necessary/voluntary to force midges into swarming, but instead to develop a kind of [question and answer], to listen and to respond to the phrases of the mosquitos” ([Damm n.d.](#b-9781474207935-005-0000139)). The *Drosophila* Karaoke Bar functions similarly: human speech and songs are transformed to frequencies that flies respond to, while the sounds and behaviours generated by the flies are translated back into the human world.

The work of Stephen Willats continues the theme of art as interface but now between people rather than humans and non-humans ([Irish 2021](#b-9781474207935-005-0000187); see also [Noble 2021](#b-9781474207935-005-0000229)). Willats studied with Ascott in 1962–3 and taught alongside him in 1965–7. In the 1960s he also worked with Gordon Pask at Pask’s company, Systems Research, and a cybernetic device built by the cybernetician W. Ross Ashby in 1948, the homeostat, played an important role in his artistic development ([Pickering 2010](#b-9781474207935-005-0000267): ch. 4). The homeostat was an electro-mechanical device which experimentally reconfigured its inner workings in adaptation to its environment, modelled in Ashby’s work by other homeostats acting likewise, and Willats aimed at artworks that would set up novel homeostat-like relations between individuals and groups. His 1973 work *Meta Filter* served as an interface through which two participants could try out different understandings of given concepts until some sort of agreement could be reached. Later works acted as interfaces between social groups. The *Edinburgh Social Model Construction Project* in 1973 drew on interviews and photography in two Edinburgh neighbourhoods distinguished by social class, and used publicly exhibited photos and texts to provoke reflections on the different lives lived by different residents. Ascott’s themes of “feedback, dialogue and involvement” are clearly evident here, as is the decentring of the artist and emergence in art: Willats’s interfaces grew in time, and he had no specific end point in mind; the aim was for the participants to find out where they would end up.

## Happenings

If you replace technical interfaces like Damm’s and Willats’s with contrived social environments you arrive at what used to be called happenings, “events that, put simply, happen” ([Kaprow 1961](#b-9781474207935-005-0000198): 3). Associated primarily with Allan Kaprow, a minimalist version would be Kaprow’s 1961 *Yard* ([Hauser and Wirth 2017](#b-9781474207935-005-0000182)) in which the setting was a random pile of tyres that participants clambered and danced over and around. The aim here, as always, was not defined in advance; it was, rather, to find out what would happen with a specific group of people in a specific setting on a specific occasion—a form of unscripted and decentred theatre in which the “audience” constructed the work. The cybernetic aspect of happenings was again to thematize performance and, especially, emergence, now in the open-ended adaptation of people to the behaviour of one another and to their non-human environments.

Happenings as such were a short-lived phenomenon of the late 1950s and early 1960s, but it is interesting to look both back and forwards from them. Kaprow discussed their origins in Dada and the work of both John Cage, with whom he studied, and Jackson Pollock—all of which in different ways foregrounded emergence and becoming ([Kaprow and Lee 1966](#b-9781474207935-005-0000201)). Kaprow’s work fed in turn into the multimedia happenings of the later 1960s—social gatherings, parties and concerts taking place in rich environments including sounds, music, light shows, strobes and, often, psychedelic drugs, thus shading into the technologies of the self discussed in the next section (see [Turner 2006](#b-9781474207935-005-0000332): ch. 2 on the multimedia spaces created in the 1960s by USCO in the US, leading up to the San Francisco Trips Festival of 1966).

Since the early 2000s, happenings have re-emerged in the guise of the “social choreography” of choreographers William Forsythe and Michael Klien and dramaturge Steve Valk ([Forsythe n.d.](#b-9781474207935-005-0000150); [Klien and Valk 2007](#b-9781474207935-005-0000206), [2008](#b-9781474207935-005-0000208)). Like happenings, the emphasis is still on unplanned emergence in social groups, though now in pursuit of social transformation. *White Bouncy Castle*, from the late 1990s, for instance, was indeed an enormous bouncy castle inflated in Frankfurt and London ([Forsythe 1997](#b-9781474207935-005-0000152)). Participants found their habitual patterns of movement disrupted by those of others via the movement of the castle itself. Valk speaks here of disrupting the “tendon-cies” of participants, routinized blueprints for bodily action which in a non-dualist fashion sustain everyday understandings and social relations ([Lewis and Valk 2020](#b-9781474207935-005-0000211): 5). In this sense, social choreography is “exo-pedagogy”, deliberately interfering with normalizing forms of institutional education. Valk crystallizes the ambition of social choreography by comparing it with Balinese theatre and dance as reported in the 1930s by one of the founders of cybernetics, Gregory Bateson ([Klien and Valk 2007](#b-9781474207935-005-0000206): 1–2, passim). In the middle of a long performance some of the Balinese performers fell into an altered state, a trance. The hope is that similarly drastic transformations will happen in London and Frankfurt.

## Technologies of the Self

Reference to psychedelic drugs and trance leads us to technologies of the self ([Foucault 1988](#b-9781474207935-005-0000154)), non-symbolic performative systems that act directly to transform the inner being of participants, “deep levels of experience” as Roy Ascott put it (see also [Kandinsky 1977](#b-9781474207935-005-0000195) and [Artaud 1970](#b-9781474207935-005-0000102)). In the history of cybernetic art the most brutal such technology is the use of stroboscopes, “flicker”. Again this history begins with cybernetician Grey Walter, not with his robots this time but with his electroencephalographic (EEG) research in the 1940s into the effects of strobes on brainwaves, fluctuating electrical potentials in the brain ([Walter, Dovey and Shipton 1946](#b-9781474207935-005-0000348); [Pickering 2010](#b-9781474207935-005-0000267): ch. 3). In his popular book *The Living Brain*, Walter discussed the surprising optical effects and visions induced by staring into a strobe with eyes closed, including a striking quote from the writer Margiad Evans:

Lights like comets dangled before me, slow at first and then gaining a fury of speed and change, whirling colour into colour, angle into angle. They were all pure unearthly colours, mental colours, not deep visual ones. There was no glow in them but only activity and revolution.

— ([Walter 1953](#b-9781474207935-005-0000345): 101)

As John [Geiger (2003)](#b-9781474207935-005-0000165) has shown, Walter’s discussion was picked up by the writer William Burroughs, who introduced strobes to the Beats and thence to the art world in general, where flicker has flourished ever since. Another of the Beats, Brion Gysin, exhibited a whole series of home-made strobes or Dream Machines as he called them—“the first artwork in history made to be viewed with closed eyes” (Gysin, quoted by [Geiger 2003](#b-9781474207935-005-0000165): 54). As noted above, strobes became a standard part of the multimedia happenings of the 1960s, and have multiplied, if anything, in the twenty-first century ([Salter 2015](#b-9781474207935-005-0000292)), including, for example, Matthijs Munnik’s *Citadels: Common Structures*, a 20-foot flashing tower exhibited at the Sonic Acts festival in Amsterdam in 2013, accompanied by deafening low-frequency sounds (matthijsmunnik.nl).

Chris Salter ([2015](#b-9781474207935-005-0000292): ch. 3) describes in detail a sequence of three installations constructed with collaborators in 2010 and 2011 which extended the range of artistic technologies of the self to multi-sensory environments: *Just Noticeable Difference*, *Atmosphere* and *Displace*. In specially constructed spaces, participants experienced fluctuating combinations of lights and strobes, sounds, heat and tactile actuators, and even unusual flavours (beginning with bitter, chilli-laced chocolate and getting stranger). The aim was “a shift in consciousness” (ibid.: 183) somehow parallel to the effects of the psychedelic drug ayahuasca (ibid.: 189, 196). Emergence, now of novel sensations, was again a central interest of these works—“we don’t really know what we are making, we also don’t know what these materials will do” (ibid.: 190)—and interviews aimed to find out how participants had processed their experiences.

Another prominent technology of the self is bio-feedback art, which can once more trace its ancestry back to Walter, who experimented with ways to feed back brainwave patterns to his subjects to make possible conscious control, and also discovered that locking strobe frequencies to oscillations in brainwaves induced epileptic symptoms in more than half of his experimental subjects ([Walter and Walter 1949](#b-9781474207935-005-0000351); [Pickering 2010](#b-9781474207935-005-0000267): ch. 3). A foundational bio-feedback artwork was Alvin Lucier’s *Music for Solo Performer* from 1965, which used an EEG brainwave readout to control the sounds generated by “gongs, timpani, bass drums, anything that loudspeakers could vibrate sympathetically” ([Lucier 1995](#b-9781474207935-005-0000214): 50). The circuitry was structured so that sounds were only generated when Lucier achieved a state in which alpha-rhythms dominated his brainwaves, in a bio-feedback arrangement which helped him maintain a transcendental meditative state (early flicker artwork likewise focused on alpha-frequencies).

Richard Teitelbaum introduced a social element into EEG-feedback music, and: “With five musicians simultaneously engaged in the same activities—electronically mixing, inter-modulating with each other and issuing from the same loudspeakers—a process of non-ordinary communication developed, guiding individuals into collective consciousness, merging the many into one” ([Teitelbaum 1974](#b-9781474207935-005-0000308): 57). Much subsequent bio-feedback art has thematized the interference of brainwave patterns of two or more participants. For overviews of the development of bio-feedback art and music see Rosenboom ([1974](#b-9781474207935-005-0000281), [1990](#b-9781474207935-005-0000284), 1987), [Teitelbaum (1974)](#b-9781474207935-005-0000308), [Tenney (1995)](#b-9781474207935-005-0000314) and [Lysen (2019)](#b-9781474207935-005-0000217).

To end this section we can return to the theme of control. The archetypal technologies of the self discussed by Foucault all serve to intensify self-control and a dualist split between an autonomous self and its surroundings. Stoic techniques, for example, foster a self impervious to disaster. In contrast, the artistic technologies discussed here are technologies of abandonment ([Gomart and Hennion 1999](#b-9781474207935-005-0000174)) which open the self to new perceptions, experiences and subject positions. We could think of them as technologies of the decentred, emergent and non-modern self ([Pickering 2010](#b-9781474207935-005-0000267): ch. 3).

## Conclusion

Modern art is *process* and it is open-ended. The old art was deterministic, concerned with discrete objects, with things and fixed relationships. Now everything tends to a fluid state, a continual changeability.

Roy Ascott

— ([1968](#b-9781474207935-005-0000105): 106)

I have mapped out the field of cybernetic art by following the themes laid out in the opening quotation from Roy Ascott. One way to pull the threads together is in terms of a distinctive cybernetic ontology or worldview. This is a picture of the world in general as a lively place, always liable to surprise us, ultimately unknowable ([Pickering 2008](#b-9781474207935-005-0000256), [2010](#b-9781474207935-005-0000267)). The various themes all pick up aspects of this picture: the emphasis on agency, performance and emergence (rather than knowledge, symbols and meaning), the decentring of the artist (relative to the work and the audience) and the surrender of control, the importance of feedback and adaptation as the locus of interaction with the world, the construction of interfaces, and technologies of the self, understood as itself open to performative experimentation. Collectively, we can understand cybernetic art as ontological pedagogy, helping us to grasp the world as lively and unknowable, giving us “the chance to experience what might be quite dangerous and radical new ideas”, as Brian Eno put it ([1996](#b-9781474207935-005-0000141): 8). Conversely, of course, cybernetic art functions as an existence proof, showing us that and how it is possible to make art in such a world—and how different it is from conventional art.

We can appreciate the force of these remarks in terms of the contrast between the cybernetic ontology and the ontology of modern science, with its dualist vision of a fixed, knowable and controllable world. The scientific worldview is what we teach our children. It runs through the fabric of modernity. In this sense cybernetic art helps us to grasp the world differently.

I have not discussed the politics of cybernetic art here, and there is little novel about it in terms of conventional political positions. However, as set out in Alexander Trocchi’s ([1991a](#b-9781474207935-005-0000320), b) sigma project from the 1960s, as a non-modern ontological politics of practices it could hardly be more subversive and revolutionary ([Trocchi 1991a](#b-9781474207935-005-0000320), b; [Pickering 2017](#b-9781474207935-005-0000270)).

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This article explores digital photography, situating it within a line of continuation with that of its predecessor, analogue photography. The first part will discuss where the two converge historically, but also demonstrate where digital photography has given rise to new and different categories. In the following subsections, digital photography will be expanded through key terms that apply to it.

*Fluidity* of the digital image will pinpoint the emergence of digital photography as essential to the understanding of it. *Algorithmic* will analyse the code and software of digital photographic files, as well as the meaning associated with this term. *Excess* will engage with the sheer quantity and speed of distribution of online images, via the internet as well as social media. Sluis and Rubinstein’s “networked” image will be explored alongside the work of practitioner Penelope Umbrico and her project *Everyone’s Photo Any License and Related Projects* (2015–16). *Quality* will discuss the issues of compression, file naming, like JPEG, but also the idea of the “poor image” as proposed by Hito Steyerl. The Abu Ghraib photographs will also be discussed as examples of poor images.

*Selfie* will discuss the changing notion of self-portraiture alongside the rise of the selfie (2013, Oxford English Dictionary), looking at the work of Amalia Ulman and her online identity. The section on *Witness* will explore the shifting role of documentary photography and photojournalism alongside the rise of social media and online distribution of photographs, and the Arab Spring will be looked into as well as the term “citizen journalism”. *Street View* will highlight the rise of Google Maps as well as the rise of surveillance cameras and artificial intelligence. Finally, *Artificial Intelligence* will touch on the area that is fast taking over in the field of photography, leaving algorithms to do the work and create new photographic imagery but also shape the era of face recognition and surveillance. In the *Conclusion* post-photography as a term will be suggested as a closing remark as this is something that most authors writing on digital photography agree on.

A key issue with the rise of the digital has been the reliance on naming deriving from digital software companies. Google Imaging, Instagram and Facebook have irreversibly entered our lives. In this article, where possible, the corporate equivalent will only be mentioned when deemed necessary by the author, in an effort to steer clear of this over-corporatization.

The photograph *After Man Ray* ([Figure 6.1](#b-9781474207935-006-0000004)), by the artists’ duo Anthony Aziz and Sammy Cucher, is one that connects the history of photography with the advent of new technologies and the digital era. In this photograph, from their Dystopia series, they pay homage to Man Ray’s iconic Surrealist image titled *Black and White* from 1926. While the photograph here relates to the long-standing tradition of analogue photography, as it was a print made in the colour darkroom (C-Type), hence it was captured on film, it also heralds its departure. Digital photography coexists with its historical predecessor—the world of analogue photography—but it also necessarily has many differences.

While there have been at times attempts by authors to describe digital photography as somehow in opposition to its historical predecessor of (analogue) photography, this merely highlights the question of when and how photography became digital.

The definition of “digital photography” poses a wider problematic, because one can’t pinpoint the exact moment when the photograph became digital. As curator Eva Respini notes, the moment is difficult to untangle from the convergence of various digital platforms and technologies ([Respini 2018](#b-9781474207935-006-0000287)). Even more complicated is the fact that analogue photography continues to coexist alongside digital photographic processes in both artists’ studios, in educational institutions, as well as in the vernacular practice of taking photos with disposable cameras. For W. T. Mitchell in his seminal *The Reconfigured Eye* ([1994](#b-9781474207935-006-0000264): 64) the practices of digital imaging and analogue photography intersect at the brief moment of image capture. For others, like Geoffrey Batchen, the digital is in fact an image that contains “the look” of photography without actually being a photograph ([Batchen 2002](#b-9781474207935-006-0000191): 140).

The artists’ works chosen here are exemplary in the sense that they capture the rise and explosion of digital photography. As in the example of Aziz and Cucher’s photograph *After Man Ray*, there is a distinct difference attached to how the artists attempt to create human portraits. The politics of identity, visibility and invisibility that was shaped by the widespread use of the internet in the 1990s gave rise to censorship of the human face. By erasing eyes and mouths and performing a skin-grafting operation on their photographic portraits, the artists’ work points to a new era, where humans are now living in a world defined by computer science and mass surveillance.

Before we look at the examples that tie digital photography into contemporary practices, we can highlight some key historical developments that facilitated the transition of the photograph from its purely material, celluloid support on film, to a digital binary encoded file that can be captured, stored, compressed, archived and viewed simultaneously on a computer or handheld screen, such as an iPhone.

Indeed, digital photography is not necessarily a new medium or invention: rather, a continuation of a former medium aligning with new technological breakthroughs. Funding for these types of innovations came from highly politically motivated and government-funded schemes, especially in the US, like NASA’s Jet Propulsion Laboratory in California, or the Bell Laboratories in New Jersey ([Gertner 2012](#b-9781474207935-006-0000229)). Silicon Valley and computer companies have led the way, with Apple and Microsoft at the forefront. Photoshop was first called Display, a computer program invented by the Knoll brothers and sold to the Adobe corporation, which capitalized and rebranded it as what is its household name today. Instagram, the social media empire that has been bought out by Facebook and META, was the brainchild of Silicon Valley computer programmer Kevin Systrom ([Frier 2020](#b-9781474207935-006-0000220): 7). Innovation, while at times reliant on individuals, is now becoming subject to corporate allowances and a capitalist-driven economy that values higher streams of revenue over invention.

While the distinct stages of innovation or advancements that assisted the transition to a digital photographic era are much more difficult to pinpoint than the early experimental practices of pioneers that led to the photographic invention, nevertheless there have been key moments that allowed for the transition towards a digital era of photography to unfold.

Photography has been tied to significant technological and scientific advancements since its historical emergence in 1839, as a convergence between science and nature. In his book *Pencil of Nature* ([1844](#b-9781474207935-006-0000316)–6), W. H. F. Talbot described photography, or the act of capturing something in front of a camera, as letting nature “draw its own picture”. From the turn of the century, advertisements of the George Eastman Kodak corporation, accompanied by the famous slogan “You take the photos, we do the rest”, emphasized the ease of pressing a button to take a photograph. What has changed today, then? One may argue, isn’t it still all about pressing a button, whether on a digital SLR camera or on the virtual button of the mobile phone?

The historian Mary Warner Marien writes that “until the advent of digital photography, the negative was the element of photography in which many photographers took the most pride” ([2012](#b-9781474207935-006-0000334)). Talbot’s invention was based on the idea of reversing the tones on a negative, so that a positive print could be obtained, initially through paper negatives. The industrialization and appearance of other materials, such as celluloid (borrowed by photography from the film industry), allowed for roll films on spools to be produced.

Celluloid film was capitalized by the Kodak Eastman corporation. The first small and portable Kodak camera, with a roll fill of 100 exposures, was introduced in 1888. Ironically, Kodak was the last to keep abreast of the technological developments, even when one of the engineers working for the company had the foresight to predict the rise and impact of digital photography. Steve Sasson’s first prototype of a digital camera in 1975 remained a prototype and at the time was not further developed by Kodak as a viable commercial product. While eventually Kodak did move into the digital world, it was already too late to catch up with the tidal wave of the digital era. The company declared bankruptcy in 2012, suspending the production of 35 mm film.

Despite the advent of colour photography and introduction of Polaroid film in the 1970s, the idea persisted that black-and-white photography was precise, accurate and faithful. For the documentary street photographer of the decisive moment, like Henri Cartier-Bresson, the world was only to be seen in black and white. Landscape photographer Ansel Adams’ much celebrated Zone System was in effect a method of achieving the perfect black-and-white negative, from which a positive print could be obtained later in the darkroom.

In his study of *Black: The History of a Color* the art historian Michel Pastoureau also notes that “for more than a century, the world of photography was a world of black and white” ([2008](#b-9781474207935-006-0000278): 178), evident in the black-and-white press photographs destined for newspapers.

Coincidently, the world is still understood by camera sensors and computers as well as software programs, like Photoshop, in scales of black and white. Camera sensors register intensities of light, automating and converting the information into electric signals of encoded information. Light from a scene captured through a photographic lens is now formed onto a sensor, rather than on film. The digital image captured is a greyscale or monochrome encoding, with colour encoding applied at a later stage ([Baraklianou 2012](#b-9781474207935-006-0000175)).

## Fluidity

Fluidity of digital technologies is the opposite of the desire for capturing and “fixing” images in analogue photography.

The concept of fixing a brief, yet transient, moment in time is still at the heart of the photographic (capturing) process. The historical desire to “fix an image”, as Geoffrey Batchen ([1999](#b-9781474207935-006-0000188): 21) has pointed out, has evolved into the rather more fluid concept of alteration and the openness of the digital file. What has remained, at a fundamental level, is the desire to capture rays of light inside the camera, screen or apparatus. Light remains the definitive material or principle upon which all photography, and, consequently, digital photography, is based.

Developments that led to a breakthrough in acquiring digital images were spearheaded by NASA’s Jet Propulsion Laboratory. Indeed, between 1964 and 1965, the JPL was one of the first places to render analogue image-transmission signals, from the spacecraft Mariner 4, into numerical binary encoding, leading to the first digital images of the planet Mars ([Mitchell 1994](#b-9781474207935-006-0000264): 69–72).

The term “pict” or “pix” was first used to describe the smallest visible element of the image file on screen. Terms that have now define the processing and calculation of a digital photographic file, like “pixel”, “resolution” and MB (megabytes), derive from the technical vocabulary of scientists or engineers working in either private or privately funded corporations. The scientific papers of an engineer working for NASA, Fred Billingsley, prove insightful for the introduction of new terminology in understanding the digital image. The language he uses to describe these images is associated with the “extreme flexibility of the digital approach”. Billingsley published and predicted, from very early on, the widespread impact of digital imaging technologies and uses not only for NASA’s space missions, but also for medical imaging.

Towards the end of his 1967 paper, Billingsley specifically offers a wider range of applications for their image-processing system, demonstrating the benefits through examples of medical X-rays as well as microscopic imaging of chromosomes.

The term “pixel” later entered into the vocabulary and was patented by the IBM computer company ([Lyon 2006](#b-9781474207935-006-0000257)).

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At the Bell Laboratories in New Jersey, scientists George Smith and Willard Boyle were working on making digitally encoded information viewable on a computer screen. From the late 1960s and as a result of Smith and Boyle’s experiments at Bell Labs with semiconductor memory systems for computers, digital image sensors (CCDs) were being built, with the first ever solid-state video camera being introduced in 1970 ([Langford 2011](#b-9781474207935-006-0000251): 143). These sensors captured light into an electrical charge and led to the first CCDs or couple charged devices, which can now be found in the sensors of any digital camera. By the mid-1980s, most camera manufacturers like Fujifilm and Sony were working on digital cameras equipped with CCDs. Kodak and many others were in a race to secure a patent that would be commercially viable and user friendly with the public. It was Fujifilm that unveiled in 1988 the FUJIX DS-1P, which held a storage of 2MB and took ten photographs on its memory card, officially becoming the world’s first consumer full digital camera.

In 1990, Photoshop 0.1 was launched. Initially it was sold with a scanner ([Prakel 2010](#b-9781474207935-006-0000284): 189) because having digital images was not yet fully popularized, therefore in order to obtain a digital file for manipulation it was easier to scan in an analogue print.

By the late 1980s, the rapidly advancing field of digital photography was changing the way photography appeared and, more crucially, how the photographer, or operator, in the case of someone sitting in front of a computer screen, was interacting with the image.

Indeed, the sheer acceleration of CCD and chip devices, the proliferation of mobile phones embedded with portable cameras, combined with the rise of the internet and 2.0 in the World Wide Web, pushed the traditional understanding of the term “photography” into areas and domains where it previously did not necessarily exist ([Mitchell 1994](#b-9781474207935-006-0000264)). For other authors (e.g. [Rubinstein and Sluis 2008](#b-9781474207935-006-0000296)) the term “digital photography” should be articulated either as “algorithmic image” or “computational image”. Writers and academics are now talking about the “networked” image ([Lister 2013](#b-9781474207935-006-0000254)).

Never solely a fixed entity, printed and viewed on a page of a newspaper or magazine, photographs have become digital objects that remain open to alteration and manipulation.

The “indexicality” ([Barthes 1983](#b-9781474207935-006-0000185); [Sontag 1977](#b-9781474207935-006-0000307)) of the photographic image, the direct association or correlation with a real object in front of the camera lens, like a footprint in the sand correlates with the real foot, has become disrupted. Effectively, through a series of algorithms, the digital image, the photograph, can be assigned another layer of signification, beyond the purely representational. This resemblance (rather than correspondence) point by point to nature (index) can also operate as a site of transference, as an inter-moment ([Baraklianou 2014](#b-9781474207935-006-0000180)).

Problems of data, resolution, compression, “workflow”, storage, distribution, copyright ([Frosh 2003](#b-9781474207935-006-0000223)) and metadata have all become synonymous with the digital image, none of which can find a reasonable explanation through semiotics alone. Fazi and Fuller speak of a modernist paradigm whereby we exchange the computational aesthetics of canvas, paint and marble for computation, “a systematization of reality via discrete means such as numbers, digits, models, procedures, measures and representations and highly condensed formalisations of relations … computation is as much a condition as it is a medium” ([Fazi and Fuller 2016](#b-9781474207935-006-0000211): 281).

Under the wider category of the digital photograph, one can understand a variety of visual outcomes, besides visual representation, which can entail manipulation, appropriation and, most importantly, abstracted images circulating either on the internet or stored in image banks, stripped of their original contexts. As Paul Frosh aptly demonstrated in *The Image Factory* ([2003](#b-9781474207935-006-0000223)), his seminal study on commercial image banks, providing storage en masse these image banks generate meaning out of content rather than context. The initial relationship between photographer, news agency, story is severed, thus cancelling the channels of the photograph’s mode of circulation. Responding to the “age of information” as coined by Geoffrey Nunberg ([Frosh 2003](#b-9781474207935-006-0000223): 196–7), the term has come to mean an intentional substance that is present in the world and appears as both abstract and universal at the same time. It maintains its autonomy from specific context, ensuring uninhibited transferability between temporally and spatially connected points, like on the World Wide Web.

The shifting nature of technology has allowed for the first time, perhaps, to consider a different ontology, one almost completely outside and above the subject/object divide. This involves the changing role of the photographer, or operator. As Joanna Zylinska has aptly demonstrated in her book *Nonhuman Photography* ([2017](#b-9781474207935-006-0000337)), in the current context of the Anthropocene “the photographic image is seen as existing in a dynamic set of entangled media relations, and hence as a process rather than as a discrete object”.

## Algorithmic

The digital photograph is in fact an iteration of a certain workflow that is captured and stored through external hardware (camera, memory cards, computer screen, phone screen) and further manipulated or prepared for print using software (Photoshop, Lightroom and others). Once captured and stored, a digital photograph is a set of binary code. In order to manipulate or process the information a certain algorithm is needed that interprets this data.

Because of their invisible nature, inside black boxes, algorithms perform operations silently and discretely in the background, without further human intervention. This often gives them the “God-like” powers of acting for the user, before the user even knows it. Algorithms can track, trace, perform, gather information but also change the look of a certain photograph, with a filter.

The term “algorithmic”, then, in photography has come to denote something of a mystery to non-digital users, as it is often complex and relates to fields traditionally not associated with photography. As Matthew [Fuller (2008)](#b-9781474207935-006-0000226) writes “the story of photography will be in no smaller part, the kinds of compression and storage it undergoes, as they in turn produce what is conjurable as an image”. Elsewhere David [Rodowick (2007)](#b-9781474207935-006-0000293) concludes that digital acquisition quantifies the world as a manipulatable series of numbers. The “algorithmic turn” is what [Rubinstein and Sluis (2008)](#b-9781474207935-006-0000296) deem a major factor of computational or networked images ([Lister 2013](#b-9781474207935-006-0000254)) and the emergence of the post-photographic era ([Mitchell 1994](#b-9781474207935-006-0000264)). It designates the operative status of the photographic image ([Manovich 2001](#b-9781474207935-006-0000259)) and the user or operator, as opposed to the traditional photographer.

Algorithms are code designated for executing repeatable formulas for certain operations, for example copy-paste and cloning. Often, algorithms contain massive amounts of “space” in the form of RAM and in some instances take excessive time to render. What began as a means to create repeatable formulas by the few engineers and coders working with software in the beginning has now become accessible and more user friendly, with the widespread impact of Photoshop. As William Uricchio notes, an algorithm is a process with two main characteristics: it is finite and it is repeatable ([Uricchio 2011](#b-9781474207935-006-0000329)). Photographs captured digitally as we recognize them today only came after the rise of commercial and widely available digital DSLRs, as mentioned above. Therefore, image manipulation software developed almost separately to that of the digitally captured image. Analogue photographs had to be scanned in first, in order to acquire a digital version that could then be manipulated ([Cotton 2015](#b-9781474207935-006-0000202)). This practice widely continues, as it is common to scan a photographic negative or print and mimic the results of the darkroom on screen.

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The Dutch artist Constant Dullaart has been at the forefront of creating artworks that comment on the blurring of boundaries between artist, tech community and authorship. Most of the work takes place online, as a virtual performance. His online project in 2013, *Jennifer in Photoshop* ([<https://jennifer.ps/>](https://jennifer.ps/)), is a play not only on authenticity of internet-based imagery but also an important social commentary on popularizing and redistributing digital photographs. It is a photograph of a woman on a beach, on vacation, somewhere in the islands of Bora Bora. The seminal photograph was used by John Knoll, of the Knoll brothers, to demonstrate the basic algorithmic functions of copying and pasting parts of the image digitally on screen, when trying to sell their image-manipulating program, then known as Display, to Adobe. Jennifer was John’s fiancée at the time, later becoming his wife.

The fact that Dullaart chose the very first photograph ever Photoshopped describes a new sense of nostalgia of photographic imagery, in the form of media archaeology. Dullaart found this photograph of Jennifer via Facebook, blurring the boundaries between public and private even more. In order to gain permission to work with the photograph, Dullaart attempted to reach John Knoll. He published his correspondence as an open letter to Jennifer on the internet-based digital art community Rhizome.

This work highlights the problematics of authorship in the digital internet era as well as accessibility to the software required in order to manipulate digital images.

## Excess

In 2000, singer and actress Jennifer Lopez and the green Versace dress she wore at the 42nd Grammy Awards were set to make internet history, literally: users trying to Google Jennifer and her dress caused an upsurge in demand that Google search algorithms could not handle. Google developers therefore made it possible to search for an image using another image. By late 2001, the “image” option search was already indexing 250 million images, growing within a decade to 10 billion in 2010.

The wealth ([Lister 2013](#b-9781474207935-006-0000254)) coupled with the speed of image ([Crary 2014](#b-9781474207935-006-0000205)) and photographic distribution have led to the term “networked” image. Roughly associated with the emergence of Web 2.0 in 1999, it also coincided with the introduction of cameras on mobile phones. The first mobile phone to integrate a camera was the Sharp J-SH04, in 2000, a Japanese phone that sold in millions. Soon after, Ericsson and Nokia followed in Europe. However, it was the launch by Apple corporation of the first smart phone—the iPhone 2G (2007), integrated with not only a camera but also an internet connection—that led to the true revolution in the new era of social media. The iPhone allowed for a touchscreen with apps, which made social media like Facebook and Instagram a huge hit immediately, as users could upload and share images instantly on the web.

The social media app Instagram, initially launched in 2010, attracted 30 million users in under eighteen months, sharing an average of 5 million pictures per day. It was subsequently purchased by Facebook in 2012 ([Frier 2020](#b-9781474207935-006-0000220); [Palmer 2013](#b-9781474207935-006-0000272)) and has become one of the main apps for uploading and sharing photographs and images, overtaking Flickr and Tumblr. Some 3,500 are uploaded every second on Facebook alone ([Ritchin 2013](#b-9781474207935-006-0000290)). The wide circulation of images, however, does not coincide with the physical printing of them. While before, with analogue photography, printing out from the negative was essential in order to view images, this is no longer true with digital images. The Dutch artist Erik Kessels took the project to heart in 2011 and physically printed out photographs that had been uploaded over a 24-hour stream on social media, including Facebook, Flickr and Instagram. The installation, titled *24HRS in Photos*, amounted to 350,000 images and filled the entire space of the Foam gallery in Amsterdam.

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The impact of physically printing the amount of uploaded images could potentially look like a stacked line from the Earth that reaches all the way to the Moon, a distance of 384,400 km. The sheer mass of digital images flooded the internet, leading to an overabundance of photographs as well as their redistribution. [Rubinstein and Sluis (2008)](#b-9781474207935-006-0000296) have drawn parallels between this and the pornographic industry, where consumers take pleasure in the never-ending stream of images available on demand. All social media invest in the plurality and seemingly democratic convergence, via the internet: anyone can take part, create an account on Facebook, Instagram, Flickr and become a celebrity for their five seconds in the constant stream of the social media spotlight. The question is no more of making or circulating images, but rather, who is looking at and how many likes your profile generates.

The proliferation and circulation of images on this unprecedented scale came with many caveats, not least of all the ease with which pornographic images circulate.

For the New York based photographic artist and educator Penelope Umbrico, the constant surplus of online images has become the material for her photographic projects. By using tags and search engines on Flickr, she found that one of the most photographed subjects uploaded and shared online were “sunsets”. Focusing on this virtual subgenre of sunset images, taken on smart phones, she created a physical installation, titled *Suns from Sunsets from Flickr and Related Projects* (2006–ongoing). A visual kaleidoscope that started by incorporating 541,795 suns taken from sunset images uploaded onto the social media website, she printed these as 4 x 6 inch standard machine prints. Umbrico’s work is a comment on the ever-increasing images proliferating online by web-based photo communities that keep sharing their images of sunsets, as a collective practice, taking photos, uploading, tagging and sharing.

The initial project has led to further spin-off projects including *Suns from Sunsets from Flickr/Airmail* (2009–ongoing), which comprises postcards of her installations that curators and friends have taken in front of the installations, and *Copyrighted Suns/Screengrabs* (2009–12), which questions the claim of ownership of images as it exposes the “watermark” that comes with sunset images from stock photography websites.

Similarly, in her *Everyone’s Photos, Any License and Related Projects* (2015–16), she came across Flickr of photographs of the moon. As opposed to the ubiquitous sunsets taken on smart phones, photographing the moon requires specialized equipment and photographic knowledge. However, a quick search on Flickr soon revealed the sheer amount of technically proficient photographs of the moon, with an image licence incorporated: 1,146,034. By requesting permission from the photographers to use their images, she subsequently printed out 654 of these in order to fill a wall. The project not only questions the image copyright of the photographers, but also brings to light the complexity of sharing, uploading, attribution and licensing of photographs in the digital and internet era.

To the discussion on whether or not the term “vernacular photography” is relatable to these types of sharing practices she replies “I’m not sure the term ‘vernacular’ applies anymore—vernacular implies local idiosyncrasies but social media has made everyone globally aware and visually literate” ([Umbrico 2020](#b-9781474207935-006-0000328)).

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Apps have now become staples of online image control and persuasion, including the “swipe right” of the dating app Tinder, but also of illegal click farms that have appeared in many developing countries, allowing for someone to pay for or hire “likes” or clicks on their websites and social media profiles.

## Quality

Whether the photograph continues to exist in analogue or algorithmic form, compacted onto a digital file or remaining as part of a single frame, one of the most important aspects of digital photography has been the progressive move to higher image quality. A staple of the relatively good or adept photographer, quality of an image was more or less assured in the days of film photography. Resolution dependency has now become a large part of the equation when discussing digital images. In many ways, digital capture can fully substitute the notion of the subject photographer, via automated capture, for example via CCTV footage that is captured by a non-human operated camera. AI substitutes the need for a human who creates images from original photographs. The explosion of AI-generated imagery has its roots in satellite systems of warfare and control, which led to remotely controlled imaging systems. On top of that, Google imaging and sophisticated search engine algorithms have led to the progressive proliferation of low-resolution imagery.

As mentioned above, software companies remain responsible for the licensing of image manipulation software. Compatibility issues for digital photographic files are inherent in the way these are controlled and standardized not by users but by the manufacturing camera and computer companies. Different companies have opted for different name extensions of digital files. For example, the DNG, or Digital Negative image, file has been adopted by Adobe. This is a RAW file that behaves like a truly digital negative. It has not been widely adopted by all camera manufacturers, however, who opt for a variety of other extensions for their RAW digital files (NEF, short for Nikon Electronic Format, from the Nikon corporation).

There are a few standardized formats for digital file extensions, like JPEG, TIFF and RAW. The general consensus is that they are the standard extensions for either compressed or uncompressed files, which the poet and critic Kenneth [Goldsmith (2016)](#b-9781474207935-006-0000232) has colloquially named “lossy” and “jaggy”.

The German artist and theorist Hito Steyerl coined the term “poor image” ([2009](#b-9781474207935-006-0000313)). Resolution dependency and visibility (or invisibility) of subject matter are entwined in the online sharing streams of social media. Weak images adhere to the availability and abundance of images, the fact that anyone with a digital camera can record, upload and share photographs online, often with no editorial control or overview.

In no other instance has the impact of the “poor image” been more significant than in the case of the photographs taken by US soldiers of Iraqi detainees at Abu Ghraib prison, during the war in Iraq. Susan Sontag writes: “photographs have an insuperable power to determine what we recall of events, and it now seems probable that the defining association of people with the war in Iraq will be the photographs of tortured Iraqi prisoners by Americans” ([Sontag 2004](#b-9781474207935-006-0000310)). The images of the detainees, which came to public knowledge in early 2004 via a CD-ROM containing the graphic photographs, were evidence of abuse, torture and human rights violations by the US soldiers towards the Iraqi prisoners.

The disturbing evidence given in court clearly demonstrated that these acts of violence were deliberately set up for the camera, and part of the “desire of the participants to visually record their activities” ([Solomon-Godeau [2007] 2017](#b-9781474207935-006-0000301)). Less of a documentary, or recording, and more of a spectacle, the photographs became evidence of sadistic and blatant cruelty. Smiling faces, thumbs-up gestures next to naked and exposed bodies, these photographs became a landmark in wartime photography. The photograph of a hooded Iraqi prisoner, his hands wired and held out in a Christ-like shape, shocked the world. Known as the “Hooded Man”, it was taken by Sergeant Ivan Frederick in 2003. Susan Sontag, in her “Regarding the Torture of Others” in the *New York Times* magazine ([2004](#b-9781474207935-006-0000310)), describes these as a unique mix of “tourist snapshot and homemade pornography”, making the Abu Ghraib images the “visual trophy” to be preserved, remembered and, always, visible. Circulating on the internet, these images attest to the new type of war imagery made possible mainly due to the ease of use of digital cameras, as well as the free distribution of these on the internet.

However, it wasn’t until their circulation through media, in April 2004, that the images started to form a unique entity of their own, on the internet. Abigail Solomon-Godeau connects the essence of the Abu Ghraib images—bordering on the pornographic, sadistic, and of morbid fascination—as an online archive that exists on the web, a forever-expanding archive that is constantly added to by the appropriations and recirculations of these images in various formats: from the uses by international media, to political cartoons, demonstrations, any original content and context of the images is constantly lost and misplaced. Examples of this include their exhibition in art venues and galleries, including the controversial exhibition titled “Inconvenient Evidence”, at the International Center for Photography (ICP) in New York (2004), as well as the iRaq posters by Los Angeles activists collective Forkscrew.

The poor image is a copy in motion. Its quality is bad, its resolution substandard. As it accelerates, it deteriorates. It is a ghost of an image, a preview, a thumbnail, an errant idea, an itinerant image distributed for free, squeezed through slow digital connections, compressed, reproduced, ripped, remixed, as well as copied and pasted into other channels of distribution.

— ([Steyerl 2009](#b-9781474207935-006-0000313))

## Selfie

Between April and September 2014, the Argentine/Spanish artist Amalia Ulman staged a five-month scripted performance inspired by extreme makeover culture, titled *Excellences and Perfections*. This included three different personalities and she acted them out via the social media sharing platform Instagram. Focusing on stereotypes of women in the online world, like the shopaholic dressed in pink, or the post-rehab wellness freak, she staged them in different settings, all roughly against a Los Angeles backdrop. Within the space of a few months her followers grew exponentially. Eventually, she had to tell them the truth about the personas. Some followers were not at all happy. “People like being lied to”, she admits (2020).

According to the *Oxford English Dictionary*, a “selfie” is a “self-portrait made in a reflective object or from arm’s length”. It entered the dictionary as word of the year in 2013, a year before Ulman’s work exploded on social media. Ulman’s photographs adhere to the definition: they are all largely taken in front of mirrors, and we can always see the mobile phone and her arm prominently featured. The term itself appears to have originated from earlier online sharing platforms. According to the journalist Elizabeth [Day (2013)](#b-9781474207935-006-0000208), the first hashtag selfie appeared on Flickr in 2004, while the term “selfie” has been tracked back to 2002 and found on an Australian online forum ([Peraica 2017](#b-9781474207935-006-0000281)). It gained momentum in the English-speaking world, providing a shorthand for a networked self-portrait. Selfie, as it has become understood and when it finally officially entered the English dictionary, is a consequence of social media platforms and the rise of social media apps, most notably Instagram.

Instagram was released as an app on the iPhone in October 2010, because this model (IOS 4) was embedded with a front-facing camera and was able to connect to the internet, which made sharing content online instant. The Instagram world grew from 30 million in 2012, to having over a billion monthly users and some 3.5 billion likes per day by November 2020 ([Frier 2020](#b-9781474207935-006-0000220)).

The infinite contest for approval and likes has led to a certain pose, look, lighting, among younger teenagers and adolescents, especially women, but, more importantly, has given rise to amateur porn culture and naked poses. This has led to an increasingly negative connotation of the selfie, as narcissistic and self-obsessed, including “masturbation of the self-image”, “pathological, celebrity fed stupidity” ([Tifentale 2018](#b-9781474207935-006-0000319)) as descriptors of selfie culture.

Women have internalized the image of themselves from porn culture, and are now generating a self-objectified gaze ([Day 2013](#b-9781474207935-006-0000208)). This self-objectified gaze is an internalized male gaze that has existed in visual culture from the feminist critique of Laura Mulvey and her influential essay ([1975](#b-9781474207935-006-0000267)). Yet there is also a sense of empowerment for younger women in being able to portray themselves like this, following the likes of such celebrities as Kim Kardashian, who in 2015 published a coffee-table book, including a selection of her personal selfies previously shared on her Instagram.

Since 2008, Lev Manovich has led the research lab Software Studies Initiative, using computational and data visualization methods to analyse some 3,200 selfies shared in five global cities: Bangkok, Berlin, Moscow, New York and São Paulo. SelfieCity.net has to date been by far the most comprehensive and in-depth study of the selfie. The authors conclude that the selfie is situated within the broader context of image culture, including histories of photography, cinemagraphic design and contemporary social media, while they situate the selfie as a subgenre of photography that differs from traditional self-portraiture.

[Manovich (2017)](#b-9781474207935-006-0000262) considers Instagram one of the native apps that is extremely simple in principle: shoot with the camera phone, upload, manipulate using the in-built filters, share online. However simple in principle, Instagram has by now become far more complex, with amateurs and professionals alike utilizing it as a promotional tool for their businesses. The traditional square format has remained, whereas photographers have become increasingly aware of the possibilities for sharing their work, captured with specialist cameras and studio lighting, to the point now that amateur photographers have, in their turn, invested in professional lighting. Indeed, photography is proving more popular than ever and YouTube offers a plethora of lighting tutorials. The most “liked” post on Instagram, as of November 2020, was a selfie by celebrity influencer Kylie Jenner. Already, with this post, what is evident is the extreme narcissistic self-absorbing gaze, directed at the camera, only to be returned by the self-absorbed nature of the 14,014,342 likes that the selfie had garnered. However, Kylie Jenner did not keep the record, because she was ousted from the top by a photograph of an egg: World Record Egg day was an online project by Chris Godfrey, of the advertising agency The & Partnership, in order to topple influencers and steer the public towards mental health issues. Eugene, the egg that cracked, became the most liked post since appearing in January 2019 ([Brandwatch 2023](#b-9781474207935-006-0000197)). By March 18, 2019, it had reached over 53.3 million likes.

According to Ana Peraica, the selfie is a mirroring photograph, as the process of seeing is simultaneous to the one of recording ([2017](#b-9781474207935-006-0000281)). On September 18, 2012 the Japanese astronaut Aki Hoshide took one such mirroring selfie, which in fact was an orbiting selfie in space taken at the International Space Station. The selfie adheres to the practice of making one arm visible, in this case the astronaut’s; however, this one goes beyond that. In the concave reflection of his space helmet, the Earth below, two portions of robotic arms, his spacesuit, the deep darkness of space and a very unusual camera for taking the picture are visible.

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While not taken on a mobile phone, this unusual photograph encapsulates the dizzying converging planes of mirrored images, explored by Peraica, and the distortions of interior spaces afforded by complex camera settings vis-à-vis the camera or mobile phone. But here, the astronaut’s selfie goes beyond our long-held understandings of perspectival space, as it was taken in outer space. The astronaut has no centre of gravity, defying completely the space and mirror divide, affirming even more the visual paradoxes of the selfie.

## Witness

The distinctions between amateur and professional in the photography business to an extent have been maintained with digital photography. However, the boundaries are blurring significantly ([Umbrico 2020](#b-9781474207935-006-0000328)). The idea of the “citizen journalist” necessarily leads to the breakdown of traditional genres. Editorial photography is not only authored within a system of editorial control, but is also readily available via social media.

The addition of a camera to the mobile phone was not in itself that significant in the landslide of what would later occur: rather, it was the ability to connect to the internet with an iPhone that lent itself to events like the Arab Spring.

In the early days of the Arab Spring, social media and citizen journalism bypassed mainstream and state-controlled news outlets to share reports of political uprisings ([Respini 2018](#b-9781474207935-006-0000287)). During the protests, photographs and videos were used not only to document the events, but also to encourage more citizens to join the uprising. Thousands of photographs were taken by professionals and amateurs, and further “posted”, “shared”, “retweeted” and commented on. These photographs triggered discussions, they were used by different parties to aid their agendas and, at the same time, discouraged fellow citizens from joining the protest or encouraged them to do so. Digital technologies do not determine social or political changes, the internet and mobile phones are not simply services and gadgets: they are organizational forms, cultural expressions and specific platforms for political autonomy ([Castells 2009](#b-9781474207935-006-0000199)).

Ariella Azoulay, in *The Civil Contract of Photography* (2008), discusses the empowerment that social media offers for Palestinians, through enabling a citizenry of photography outside of sovereign state power. By taking account of the representation of their own imagery and documenting their own struggle, it offers Palestinians a means for practising politics. In a similar vein, albeit with a completely different purpose, one also sees the plight of refugees from Syria, who document their journeys of migration into Europe, utilizing their mobile phone cameras. Instagram, a social media platform associated with the selfie and celebrities, as we have seen above, is also providing a platform for the self-organized Instagram account now\_you\_see\_me\_moria, run by the Afghan refugee Ahz, at the Moria refugee camp at Lesvos, Greece. Ahz’s account gives glimpses into the everyday life of the refugees who are stranded in the camp, while at the same time demanding attention from European leaders to act.

Fred [Ritchin (2013)](#b-9781474207935-006-0000290) highlights how the term “citizen journalism” has become a catch-all for anyone, ranging from the Arab Spring revolutionaries to neighbours concerned about what is happening next door. The fact that mobile phones are equipped with cameras has, however, shaped the way news footage and journalists, as well as photojournalists, now generate content. The demand for video and audio alongside still images is fast becoming entwined with reportage and photojournalism.

On May 25, 2020, a video recording of George Floyd, being held down by police officers in Minneapolis, Minnesota, went viral. His last words of “I can’t breathe” became a slogan and accompanied the widespread protests of the Black Lives Matter movement and all those demanding justice for his murder. Had it not been for the video and audio recording, the still images alone would have not perhaps had such an impact or assisted in the trial of the policeman that was charged with the murder of George Floyd.

## Street View

In contemporary society, algorithms seem to have taken over the role of communications, controlling many aspects of how we live and interact. The idea of “digital religion” and the culture of the digital as native to our contemporary society elevates computational functions of algorithms to a fetishistic status ([Finn 2017](#b-9781474207935-006-0000217)). If algorithms are now at the heart of communications, hierarchies, military operations and AI, as well as responsible for more intimate human relationships, like in matchmaking, then it is no wonder that they have become the contemporary, modern-day black boxes.

Between 2011 and 2012 the Manchester-based conceptual artist Mishka Henner matched up co-ordinates from online forums that shared the locations of sex workers with those from Google Street View maps and acquired still photographs of street views on the outskirts of major European cities including Madrid, Rome, Bologna and Milan. The stills eerily depict isolated figures of women soliciting sex, appearing on the edges of the Street View maps, in what otherwise look like natural landscapes and empty street views.

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Google Street View is an interactive technology that was initially introduced in 2007 in the US, and has since then spread to the rest of the world. With Google Street View and also Google Earth, anyone can now search online for a spot using its geographical co-ordinates and find the exact location on the map and, since the introduction of the Pegman, scroll in to a 360-degree interactive view of the location via the panoramic photographs provided. The photographs were initially acquired from Google vans, equipped with high-end cameras that drive around specific areas capturing the footage. The sequences are then stitched into the digital panoramas. This has now expanded into the Street View trekker, the Street View snowmobile, the Street View trolley and also the Street View three-wheeler for places that are hard to access with a car or van. Other contributions come from users posting and geotagging photographs from places they have visited around the world.

Street View images are acquired with equipment and cameras that involve a combination of digital camera sensors and laser scanners, to capture precise location information. Following a host of disputes and legal battles with countries as well as individuals on the breach of consent and data involved during Google Maps’ early images, Google now uses an algorithm to blur out faces of individuals as well as sensitive information, like vehicle registration number plates ([Kember 1998](#b-9781474207935-006-0000240)). Joanna Zylinska notes that the rise of traffic control cameras, smart phones coupled with Google Street View, satellites and drone photography all add up to the fact that “photography is decoupled from human agency and human vision” ([Zylinska 2017](#b-9781474207935-006-0000337)).

Sarah Kember further suggests the conjoined elements of photography and cartography in software employed by Google Street View maps, as well as the (no longer so popular) Photosynth ([Uricchio 2011](#b-9781474207935-006-0000329)), transform the physical relation between the image and the object of its representation, as something already presented as an image on the map. User-centric surveillance, like CCTV cameras, tagging via GPS systems and also face recognition (biometric recognition) technologies, while providing solutions, give rise to a whole host of new issues. The process of data gathering or data storing does not achieve much until the data are actively retrieved and analysed. The evolving entanglement of technologies, one that does not necessarily lead to the emergence of cyborgs, posthumans or other biotechnological entities, is a hybridized form between computers, technology and humans. This leads rather to the co-evolution of humans and machines and the mass proliferation of photography in both the public and private spheres. As Google Maps adequately demonstrates, very often the private and public overlap.

## Artificial Intelligence

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The fashion photographers Inez van Lamsweerde and Vinoodh Matadin have been pioneers in creating digital manipulated imagery for *Vogue* and campaigns for fashion brands. Inevitably, they have been at the forefront of creating highly stylized imagery that comments on the reliability of the photographer as creator of the images. In the case of *Me Kissing Vinoodh, Passionately* (1999), here the female photographer Inez erases her husband from the photograph, leaving, however, the signs of the deep and passionate kiss to him, visible.

In the case of their earlier work *Kirsten*, this disquieting portrait of a young girl with her eyes closed led to the creation of a perfume, a scent based on this photograph. While scent and smell attached to photographs belong on the lighter side of things, and the idea of olfactory identification may be light years away, face recognition technology has become a lucrative area of research, with governments and institutions investing vast amounts of money in it in order to enforce surveillance and streamline identification procedures.

The emergence of the “self as data”, whereby subjectivity and citizenship shift to user activity and online presence ([Kember 2012](#b-9781474207935-006-0000243)), is evident in face recognition algorithms. The overreliance on machinic automated recognition does not come without its own pitfalls.

In the case of tracking potential terrorists, for example, face recognition algorithms consolidate imagery from photographs that are poorly lit or taken from side rather than face-on angles. For the vast majority, algorithms and artificial intelligence or neural, deep learning algorithms, which are asked to consolidate huge amounts of digital data, prove to have flaws ([Kember 2012](#b-9781474207935-006-0000243)). This is also the case in medical imaging software, as Philip [Hunter (2019)](#b-9781474207935-006-0000235) outlines in his article on AI, diagnostics and imaging in health care. With the advancements in neural network techniques, progress has been made in diagnostics for cancer patients, for example. However, machine learning and neural networks can also lead to fatal applications and diagnostics, when the images can be tampered with and hospitals and health care archives are abused by third parties.

## Conclusion

This article has explored the emergence of digital photography, and the key terminology that makes digital photography distinct from its analogue predecessor, such as “pixel” and “algorithm”. Excess of the digital explored the rise of 2.0 internet as well as the introduction of mobile phones integrated with a camera, and their ability to connect to the internet. “Selfie” is a term that has since been introduced into everyday vocabulary, while social media apps like Instagram and X (formerly Twitter) also signal the shift from photojournalism to a citizen journalism.

With the rise of AI, neural networks, deep learning algorithms as well as laser imaging coupled with light scanners (Lidar) and photogrammetry, it has been suggested by most authors and critics of the image, including Joanna Zylinska, Jonathan Crary and W. J. Mitchell, that we are now in the era of post-photography. Intelligent and sophisticated software programmes allow for deepfakes and for image manipulation to be executed by algorithms alone, leaving aside the need for human capture or intervention even, in the process of creating photographs.

The non-human aspects of capturing images do not necessarily lead to an inhumane world run by robots and cyborgs. What they do allow for, however, is an alternative viewpoint, one based not on the human-centred vision alone.

Accepting the fact that nowadays digital photography is attached to almost everything we do—whether ordering takeaway food online, finding the destination of a friend’s home on Google Maps, or looking at images of the stars and planets in outer space through NASA’s channel—will allow us to understand the hybridization of photography as a practice. The mass proliferation of images via the internet, algorithms at work in the background on smart phones and computers, as well as the ease with which photographs are embedded virtually into every aspect of life, also mean that the boundaries between public and private are more porous: “the image becomes flexible, polymorph, more than ever temporal but also corporeal” (Chantal Pontbriand, as quoted in the Introduction to [Kuc and Zylinska 2016](#b-9781474207935-006-0000248)).

Instead of understanding media and each individual component, like photography, algorithm, screen or interface separately, one needs to view the interaction between these and human agency as a process of mediation.

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This article aims to provide an introduction to and overview of the history of artists’ video, exploring its origins in Europe and the United States and tracing its development from early tentative beginnings to its rise to attain the status of an international global phenomenon. The article will discuss and identify the roots of the genre as it emerged in the late 1950s and early 1960s, examining its complex and often problematic relationship with broadcast TV and discussing the connections with, and influences from, artists’ film, “live” art and experimental music. The article will outline the numerous manifestations of artists’ video including works for single screen, multi-monitor presentations and interactive installations, identifying some of the key practitioners, influences, strategies and approaches.

The article will discuss video art’s relationship with the art gallery and museum, collectors and the art market in terms of its initial struggle for acceptance, through to the genre’s dominance as a gallery medium. The impact of some of the most significant technological developments will be discussed in terms of techniques and approaches employed for the production, display and dissemination by artists working with video, from early analogue equipment through to contemporary digital processes and their influence on the work produced and themes explored.

## ROOTS AND ORIGINS

What has come to be known as “video art” emerged after the middle of the twentieth century, initially as a direct response to television as a ubiquitous and dominant influence on the domestic and cultural landscape. Early work in the genre by artists centred on a critique of the medium and a rejection of conventional broadcast television and included efforts to create radical alternatives to the one-way diffusion of information and propaganda by national governments and large corporations. During the 1970s and 1980s, as technology developed to include methods for the recording and editing of the video signal, artists and media activists took up the increasingly accessible and affordable video equipment to explore the capabilities and potential of this electronic medium beyond the broadcast domain—often in alternative venues, but eventually including galleries and museums. As video technologies and techniques improved to approach the flexibility and capabilities of film—especially once it became possible to process the video image digitally—the two forms have increasingly merged, sharing approaches and cross-fertilizing the two formerly distinct, but related genres into what for many is now perhaps more accurately characterized as “time-based” media.

The roots of video art can be traced to the pioneering work of two men, both closely associated with the Fluxus movement and working initially in Europe. Fluxus, which emerged in the early 1950s and was to be influential on the subsequent development of conceptual art, was an approach of a loosely defined international group of artists with a radical agenda to debunk the art establishment. Fluxus artists championed a consciously anti-bourgeois approach to art making, eschewing the making of objects using conventional media in favour of live art performance “happenings”, often presenting ephemeral and temporary structures and situations. Wolf Vostell, one of the co-founders of Fluxus, began incorporating domestic TV sets into his work as early as 1958, but it is his 1963 work *6-TV-Dé-coll/age*, shown at the Smolin Gallery in New York, which is most often cited as a milestone in the early history of the medium.

However, despite Vostell’s early innovations with television, it is Korean-born Nam June Paik, who is generally credited with having produced the earliest examples of the genre. In 1963 Paik presented a series of modified television sets in his “Exposition of Music—Electronic Television”, held at Galerie Parnass in Wuppertal in what was then West Germany. Paik had joined the Fluxus movement the year before, having explored experimental music influenced by avant-garde composers Karlheinz Stockhausen and John Cage, while studying music history at Munich University. Paik’s initial work with TV sets at the beginning of the 1960s expanded over the subsequent decade to embrace the use of newly developed electronic imaging technologies including portable video recording equipment and machines which enabled the manipulation and distortion of the video signal. His reputation as the “father of video art” was earned partly as a result of his early adoption and championing of the medium and partly due to his inventive pioneering spirit and prolific output. Paik experimented energetically with video in every conceivable way, on video tape, in gallery installations and working with multi-screen displays, terrestrial broadcasting and even transmission via satellite. He was also an enthusiastic collaborator, developing new works and approaches with other artists, engineers, composers and choreographers. He was a powerful influence on the development of artists’ video in the United States, advising the Guggenheim Foundation on the support of new and aspiring artists working with the video medium. Paik’s legacy is considerable, his impact on the development of artists’ video is unparalleled and he is considered by many to have earned his epithet as the “father of video art”.

## Video Art and Technological Developments

There is an inevitable and strong interconnection between the development of video technology and the evolution of artists’ video. As improvements in the capabilities, accessibility and reliability of video equipment—cameras, recorders, processing and display—combined with the lowering of costs and improvements in the quality of the image, interest in the medium and what could be done with it grew exponentially. With the introduction of the Sony “Portapak” in 1967, artists and media activists in the United States, Europe and elsewhere began exploring the creative potential of video tape, working with the new medium to document live performances and deliberately staged actions as well as to record events and activities. Artists including Bruce Nauman, William Wegman, Martha Rosler, Les Levine, Letícia Parente, Rose Garrard and Joan Jonas, who initially worked with video because of its “real-time”, continuous recording capabilities, began to make works specifically for video tape. US media groups such as Videofreex, TVTV (Top Value TV) and the Raindance Corporation were attracted to the new medium for the freedom it gave them to present alternative perspectives from those generally available via broadcast television. Within a few years of its introduction, the Portapak and its imitators had empowered artists, politically active groups and individuals to offer alternative viewpoints to the corporate monopoly “one-way” communication of the established broadcast television system in many developed countries around the world.

In the UK the photographer and activist John “Hoppy” Hopkins championed video as a tool for radical social change, seeking ways to empower ordinary individuals by giving them a voice. Establishing a number of organizations and video groups such as “Graft on!”, CATS (Centre for Advanced Television Studios) and the Fantasy Factory with his partner Sue Hall, he attracted funding to purchase video equipment which could be made available to disenfranchised groups and in addition campaigned for so-called “low-grade” video (i.e. recordings on half-inch video made using a Portapak) to be accepted for TV broadcast. In his ultimately unsuccessful attempts to make this a possibility, Hopkins came up against strong resistance from powerful technicians’ unions as well as the governing status quo.

The development, acceptance and recognition of video art as a genre was an international phenomenon, although it had it early roots in Germany and the United States. Artists in Canada, the Netherlands, France, Poland, Italy, the UK, Brazil, Japan and elsewhere responded quickly to the power of this newly emerging technology and its potential as an art medium. The radical political developments and social unrest in Western society included an explosion of new art movements in the 1960s and early 1970s, which embraced and encouraged experimentation and alternative approaches. There was a hunger for innovation and change, which suited the new medium and helped to foster a break from traditional approaches to art and the subjects of art, as well as to the power and influence of the established museums and galleries.

## Relationship to Broadcasting

There are a number of important ways in which video art and television are intertwined. Initially broadcast television was seen not just as an opponent, but also as an alternative to the conventional art museum as a potential method of dissemination of video art. Gerry Schum’s *Fernsehgalerie* (Television Gallery) was one of the earliest examples of artwork presented to the public outside of a traditional museum. “Land Art”, broadcast April 1969 by Sender Freies Berlin in Germany, presented eight specially commissioned works by artists including Richard Long, Barry Flanagan, Dennis Oppenheim and Robert Smithson. In November the same year Schum followed this event up with *Self Burial*, a “television intervention” by British artist Keith [Arnatt (1990)](#b-9781474207935-007-0000084), which was broadcast on WDR3 over eight consecutive nights.

Valie Export’s video *Facing a Family*, which presented a middle-class family eating dinner while watching TV, was broadcast on the Austrian television programme “Kontakte” in 1971. The family was shown staring back at their TV set, mirroring the situation in the homes of many of its viewers.

That same year, David Hall broadcast his *Television Interruptions* on Scottish TV (STV) during the Edinburgh Festival. These ten short works were screened unannounced between regular evening programming. Hall’s intention was to create a break in the normal flow of the viewer’s potential relationship with their television receiver. Hall’s aim was to stake a claim for video as an autonomous art form, as in his view video had previously been defined solely in relation to broadcast television. Hall, originally trained as a sculptor, turned to video seeking to use television to reach a different audience from those who habitually visited the traditional art gallery.

In the United States the public television station Channel Thirteen/WNET set up the TV Lab in 1972 with support from the Rockefeller Foundation and the New York State Council on the Arts, running an artists in residence programme between 1972 and 1974 to provide access to broadcast-quality facilities to create new works. Artists who worked at the TV Lab during this period include Nam June Paik, Ed Emshwiller, Peter Campus, Douglas Davis, Bill Viola, Joan Jonas, Gary Hill, Skip Blumberg and John Sanborn.

Aside from these early pioneering broadcasting initiatives, opportunities to show or exhibit video work were rare during the early period and there were initially comparatively few outlets for video art. Most artists’ video was not considered suitable for television broadcast or appropriate for collection by museums and galleries in the way that was the accepted norm for other mediums. Ephemeral and transitory, video recordings at that time were fragile and unstable as well as difficult to store and preserve. Despite these reservations and general marginalization of work in the fledgling medium, there were some early attempts to market and sell video art works. London art dealer Nigel Greenwood released Gilbert & George’s video recordings of their performances in a limited edition of twenty-five at $1,000 (US) each, but collectors were sceptical and nervous about the fragility of the medium relative to the price. New York based dealers Leo Castelli and Ileana Sonnabend set up Castelli-Sonnabend Videotapes and Films in 1974 to distribute and sell artists’ moving image work and this visionary initiative helped to promote video art as potentially collectable. In 1975 the Museum of Modern Art in New York began to officially acquire video art works for its collection, purchasing a number of works including *Global Groove* (Paik), *Vertical Roll* (Jonas), *Lip Sync* (Nauman), *Three Transitions* (Campus) and *Semiotics of the Kitchen* (Rosler).

## Video Centres and Collectives

In parallel with this tentative and somewhat uneasy relationship to broadcast television and also because the genre was marginalized by conventional art venues during the early period, a number of specialist video centres were founded in North America and Europe during the 1970s. These centres offered locations in which artists could present, experience and discuss new works in the fledgling medium. Examples include the Kitchen, established by video artists Steina and Woody Vasulka and Andy Mannik in New York; Video Inn, Vancouver; Videograph in Montreal; de Appel in Amsterdam; London Video Arts in London; and Cairn in Paris among others. These centres initially began as meeting places for screening, exhibition and discussion, but also with aspirations to provide production facilities and distribution of artists’ work. They had a considerable impact on the development of video art, providing artists not just with feedback from colleagues, but also an awareness of the growing audience for their work, as well as access to new developments in techniques and equipment.

Aspiring to similar objectives, some artists established video collectives that brought together artists to pool expertise, resources and exchange ideas. Examples are Videofreex in the USA, whose members included David Cort, Mary Curtis Ratcliff, Skip Blumberg and Davidson Gigliotti; Video Hiroba, established in Tokyo in 1972 by a number of pioneering Japanese artists including Nakaya Fujiko, Yamaguchi Katsuhiro, Kawanaka Nobuhiro, Kobayashi Hakudo, Matsumoto Toshio and Hagiwara Sakumi; and the Warsztat Formy Filmowej (WFF) in Poland, whose members included Pawel Kwiek, Wojciech Bruszewski, Józef Robakowski, Zbigniew Rybczyński and Ryszard Waśko; the Black Audio Film Collective, whose members included John Akomfrah, Reece Auguiste, Edward George, Lina Gopaul, Avril Johnson, David Lawson and Trevor Mathison; and the Sankofa Film and Video Collective, including Isaac Julien, Martina Attille, Maureen Blackwood, Nadine Marsh-Edwards and Robert Crusz.

Drawing on the experience and attitudes of experimental film, the notion of Hollywood narrative filmmaking as “dominant cinema” provided the model for broadcast TV as the enemy, or at least the opposition. For some artists, broadcast TV was seen as an opponent, with artists’ video presented as the antidote, offering a potential alternative set of possibilities and perspectives to the commercially driven aspect of broadcasting and its traditional programme content. At the time, commercial television was perceived for the most part as an outward flow of information and propaganda, with the audiences as passive consumers of TV programming. As Richard Serra and Carlota Fay Schoolman’s 1973 video *Television Deliver’s People* declared, “You are the product of TV … Popular entertainment is basically propaganda for the status quo”. This perception of television provided a backdrop for the development of the counterculture in many developed Western countries and at this time artists’ video was part of a wave of experiments using alternative media made by artists seeking new horizons and fresh perspectives. In fact, many artists were attracted to video because of its lack of mainstream appeal. The new medium was perceived as an opportunity to begin a new dialogue with a different audience by artists who were looking to break with past traditions or who had felt trapped or hampered by those traditions. The fact that video art had no previous history was for many artists seen as a virtue and an advantage, a way of making a new beginning for many who felt either marginalized or disadvantaged by the status quo. This aspect of the medium appealed to a number of important feminist artists, as well as other artists from under-represented groups who wanted to explore alternative issues including those related to gender, sexuality and identity. Shigeko Kubota identified the new medium with her own perspectives on feminist ideologies, declaring in 1975: “Video is vengeance of vagina. Video is victory of vagina”, claiming the new medium for women ([Jacob 1991](#b-9781474207935-007-0000096)). For Kubota and other female artists who took up video at the time, the medium was empowering, potentially enabling them to attain the kind of recognition for their work that many felt would not have been feasible via the more male-dominated disciplines of painting and sculpture for example. This was also the case for other disenfranchised groups, who equally perceived video as a medium ideally suited to the creative aspirations of the individual. The instant recording and playback of image and sound and minimal equipment required to produce work were attractive; the Portapak was designed to be used by individuals or small groups, without the need for specialized professional skills or expertise.

Although most of the earliest video art work directly referenced and functioned in relation to broadcast TV, much of it was produced without any aspiration or intention for broadcast, but also without any clear sense of how it might be made available or reach an audience, or perhaps even if there *was* an audience for it at all. However, artists who chose to work with video sought ways to create their own context, simultaneously seeking to free art from its institutional and ideological straightjacket and to explore and develop into new formal and contextual territories. Just as it is clear that video art drew its influences from a diverse range of media that pre-dated it, including experimental film, live and performance art, avant-garde music, conceptual art, Arte Povera, dance and theatre, video art soon developed a number of significant subgenres of its own. In addition to single-screen video tapes new forms included video sculpture and installation, “abstract” video synthesis, performative documentation, “guerrilla TV”, agitprop, community action, etc. An added dimension to the complex roots of the genre is the fact that artists’ video is a many-faceted art form: in addition to the relatively easily identified and categorized single-screen format of video tape, artists have also explored the potential for multi-monitor presentations and installations, including the use of “live” closed-circuit systems as well as multiplying images across numbers of TV screens, or using the TV “box” as a kind of sculptural building block, and once projection systems became viable and accessible, abandoning the traditional and familiar rectangle altogether.

This diversity, if anything, made artists’ video very difficult to categorize or define and was therefore both an advantage and a drawback and is perhaps one of the many reasons for its complex relationship with the art gallery, as well as a disincentive to potential collectors and in the art market in general. Initially art galleries and museums were also reluctant to exhibit or present artists’ video for a number of technical reasons: The necessary equipment was cumbersome, expensive and unreliable, and the relatively small screens for television display were unsuited to many traditional screening venues but also to the museum setting as it required special viewing areas. Unlike film, which could be projected in a cinema-style environment, the comparable low-resolution television image was small and of low contrast. Additionally, sound was also intrusive, as galleries and museum display areas had not been designed to accommodate works with soundtracks that impacted on the experience and requirements of other exhibits.

The fact that most early video art works were not only visual but also had soundtracks is often overlooked and rarely discussed in detail. In fact, the soundtrack of the majority of artists’ video tapes was crucial to the content. This is especially the case in performative works where the spoken voice and spatial acoustics were of equal importance to the visuals—if not more important in some cases. This is particularly relevant when considering video works of the 1970s by American artists such as Vito Acconci, Martha Rosler and John Baldessari but also many others who sought to use the medium to present alternative perspectives on political and social ideas in many other countries and regions. It has often been stated that video was best suited to small intimate venues. Originally intended for the domestic setting, television screens were designed to approximate a one-to-one relationship between presenter and viewer—the screen proportions ideal for a so-called “head and shoulders” image with accompanying human voice.

## Abstraction and Video Synthesis

Although technically better suited to the intimate close-up, there was an initial flurry of interest in early manifestations of abstract video from galleries in the USA in the late 1960s and early 1970s. Artists including Eric Siegel, Stephen Beck, Skip Sweeny and Dan Sandin in the USA, Ture Sjölander in Sweden, Robert Cahen in France, Peter Donebauer in the UK and Jean-Pierre Boyer in Canada began exploring the potential of the video signal to generate non-representational imagery, often working with video feedback—a phenomenon produced by pointing a video camera at the TV screen display of its own image. The resulting complex patterning provided continuously evolving fluid imagery in “real time”. For a brief period, the technique was so popular with video artists that it soon became a visual cliché, and although very simple to set up, provided one had access to the equipment, the results were random and unpredictable and it was difficult to control. Video feedback was very heavily reliant on technology, producing seductively complex swirling patterns that were very much in line with the drug-fuelled counterculture of the period. However, they very quickly went out of fashion, as the technique was perceived by curators and critics alike to be fatally tied into a utopian myth that technology itself was the key to a new world order.

Some of these early pioneers also developed electronic devices to generate colours and patterns, producing abstract video tapes which some curators saw as representing a direct connection to the legacy of American Abstract Expressionist painting that had been such a dominant force during the 1950s, as well as to the so-called “absolute animation” tradition of abstract non-narrative films by artists such as Walter Ruttmann, Hans Richter, Viking Eggeling and Oskar Fischinger in Germany and later by Mary Ellen Bute, Len Lye and John and James Whitney in the USA.

## Modernism and Artists’ Video

The emergence of artists’ video in the 1960s and early 1970s also coincided with the wider formalist agenda of the period under the influence of ideas popularized by the American art critic and writer Clement Greenberg, who argued that medium specificity for a form of art corresponds with the ability of an artist to manipulate those features that are “unique to the nature” of a particular medium. Many so-called “modernist” artists became preoccupied with the materiality of the medium, its unique formal and technological processes, and the way in which this could be explored as a key to content—so for example many painters explored the qualities of canvas and pigment, while sculptors engaged with the essential nature of bronze, steel or wood. Artists choosing to work with contemporary media in the period followed suit; filmmakers examined the nature of the filmic essentials of granularity, sprocket holes and film frames, and, in so-called “expanded cinema” work, the projection event itself. So too, many video artists of the period took their cue from this approach, considering, for example, the light-sensitive surface of the TV camera tube, the properties of electronic signal and the characteristics and potentials of the cathode ray tube TV display. In works such as *Fire Writing* (1975) and *Dawn Burn* (1975) American artist Mary Lucier explored the potential of the video camera’s Vidicon tube to leave traces of the light sources that it was focused upon, declaring that “light emerges as the dual agent of creation and destruction, martyring the material to the idea, technology to nature” ([Lucier 1991](#b-9781474207935-007-0000102): 457). UK-based sculptor turned video artist David Hall also explored the light-sensitive surface of the camera tube in a number of works, including *Vidicon Inscriptions* (1975), an installation that directly engaged viewers to participate in a live interaction.

This participatory aspect was one of the most innovative contributions of early video art. A unique aspects of the closed-circuit television system is the “real-time” live image and viewers’ encountering of their own televised image, which formed the basis of a number of important early video art works. This approach could easily qualify as a subgenre of the medium. Peter Campus produced a series of installations featuring live video display including *Mem* (1974), *Kiva* (1971) and *Interface* (1975). The Japanese filmmaker and video artist Takahiko Iimura also developed a number of early installations that experimented with a live closed-circuit TV system, for example *Inside/Outside* (1971), an event that also featured an early video projection system. Tina Keane’s *The Swing* (1978) combined live performance with sculptural installation structures and a live camera system. Józef Robakowski’s *An Objective Transmission* (1973) was the first of a series of live performance works he produced that emerged as one of the most dominant forms of video art in Poland during the 1970s. The live imagery of the closed-circuit video system could also be combined with pre-recorded video tapes. Bruce Nauman explored the potential of the relationship between live and pre-recorded video in a number of innovative early works: *Live-Taped Video Corridor* and *Going Around the Corner Piece with Live and Taped Monitors* (both 1970) are some of the earliest examples of this approach. Shirley Clarke also developed a number of installations featuring this approach. Clarke, originally trained as a dancer, formed the TeePee Video Space Troupe in 1971. Clarke’s group was influential in the development of artists’ video in the United States, combining improvisational techniques from Jazz and contemporary dance that deliberately sought to blur the boundaries between participant and spectator.

## Theoretical and Critical Influences

As has already been cited, the development and rise of artists’ video coincided with a period of political and social change and has also been inspired and influenced by a number of significant theoretical writers and thinkers with respect to the content and concerns of contemporary artists, especially those working with video.

The German philosopher Walter Benjamin’s seminal essay “The Work of Art in the Age of Mechanical Reproduction”, published in 1936, envisaged a radical expansion of the influence and power of technology on the development of art. His ideas about the potential of the arts for social and political change were particularly appealing to artists who saw video as an important catalyst for the new order, in particular the way in which Benjamin’s ideas suggested that new technological processes could have a liberating effect on the role and activity of the artist.

The Canadian academic Marshall McLuhan’s writings on the influence of mass media had a significant impact on artists in the late 1960s and early 1970s, particularly his 1964 book *Understanding Media*, in which he asserted that the artist’s role in the deployment of new technologies was critically important to society. McLuhan’s theories about the properties of the televisual image and the medium as an extension of the central nervous system had been influenced by ideas drawn from cybernetics and the work of Claude Shannon on the development of information theory, which provided a highly influential system of analysis of technological systems, cultural institutions and human communication.

Several important “post-structuralist” philosophers working in France were also influential, having a significant impact on the aspirations and concerns of many artists working with the electronic moving image. Roland Barthes did much to establish semiology and structuralism as the two key methods of analysis of contemporary thought. Gilles Deleuze was the first influential philosopher to engage with the impact of the moving image on the experience of space and time in his two books *Cinema 1: The Movement Image* (1983) and *Cinema 2: The Time-Image* (1985). Jacques Derrida (1930–2004) developed theories of deconstruction, a form of analysis that requires detailed exploration of any text or artefact under discussion. Jacques Lacan’s post-Freudian approach to psychoanalysis has had a significant influence on the development of feminist theory, further extended and developed by Julia Kristeva and Judith Butler. Butler’s work has had a considerable influence on visual artists exploring issues related to gender and sexual identity and has been instrumental in the development of so-called “queer theory”. Contemporary debate on postcolonialism and post-structuralist social theorists such as Homi Bhabha and Stuart Hall drew on the postcolonial writings of Edward Said, which centred around investigations of Black identity and culture and were also important and influential for the work and ideas of Black and Asian artists.

## Video Art Comes of Age

Although still hovering on the margins of the traditional art world and considered by some to be technically and creatively inferior to film and even perhaps a passing fad, by the late 1970s and early 1980s the medium began to be recognized as a legitimate and distinctive art form. Artists working with the medium grew in confidence and expertise and the technology became more robust, reliable and, perhaps most importantly, more affordable and therefore more accessible to many artists. In this period video art became more widely acknowledged by both the public and the art world. Although at times parodied and derided, the medium was also acknowledged as “cutting edge”, albeit sometimes also more negatively considered as “trendy” and lacking in serious and long-term significance. Despite this the medium also became increasingly international, attracting artists to explore, develop and present a diverse range of new works both within a conventional screening context and as a medium for installation and live presentations. By this time video art was no longer an activity confined to the major art centres in the USA and Europe, but had spread to Canada, Japan, Australia, South and Central America and elsewhere. Significant works by artists from these countries were also being more widely exhibited. Artists working in Canada included Lisa Steele, Colin Campbell and General Idea—Felix Partz, Jorge Zontal and AA Bronson; in Brazil Sonia Andrade, Anna Bella Geiger, Letícia Parente and Pola Maria Weiss Álvarez; while in Australia Peter Callas and Jill Scott were beginning to establish themselves, extending their national reputations and gaining attention.

Another very important change was the way in which the medium began to have an impact in art schools in Europe and North America, which led to the emergence of a new generation of video artists. During this period many of the more progressive art schools in the USA and Europe set up specialist departments alongside the more established traditional areas of painting, sculpture and printmaking. Often they were developed from courses that attracted art students who were interested in exploring the creative and expressive potential of alternative media: the so-called “third area” approaches such as live performance, photography, film and sound. Many of these time-based media courses emerged because of a rising demand among incoming students, but they were also initiated by “first-generation” video artists who had embraced the medium themselves when it first began to emerge and were actively engaged with it at a professional level. In the decade between 1975 and 1985, a new generation of artists who understood and were committed to the potential of the medium entered the culture, initiating a second wave and reinforcing the perception of video as an art medium that was rapidly coming of age. By the late 1980s progressive art galleries were increasingly including video in mixed group shows as well as curating retrospective exhibitions of some of the acknowledged key “pioneers” of artists’ video such as Nam June Paik, Joan Jonas, Wolf Kahlen and Dan Graham, as well as mounting shows of works by perceived new rising stars of the medium such as Bill Viola, Gary Hill, Dara Birnbaum, Tony Oursler, Marina Abramović and Zhang Peili, among others.

## Video Projection and Installation

Although early video display screen dimensions were restricted by the comparatively small cathode ray tube screens available, with the advent of video-projection systems, artists were able to present their work on a more expanded scale and, in addition, were able to escape the confines of the conventional rectangular television format. As with other aspects of the medium, video projectors were initially both cumbersome and comparatively expensive, but commercial technological developments soon brought down costs and increased the resolution, brightness and clarity of the images. The impact of this was initially gradual, but during the period under discussion, large-scale video display for screenings and installations within art institutions grew from the occasional special event to become a regular and even crucial component of art gallery presentations and exhibitions. It is not simply that video art had become accessible and accepted, but also that it was increasingly perceived as one of the major art forms of the period. It is arguable that the rise of artists’ video is at least as much about the technological changes that took place during the period since its inception, as it is about the creative, social and political shifts that happened in parallel. In the late 1960s and 1970s artists were seeking new forms and alternative methods for creative expression, in the 1980s the rapid development and accessibility of the means of production (and post-production) contributed to its ascendancy.

In retrospect, it seems likely that the major impetus to the rise of video art within the gallery and museum context was the emergence, development and rise of video installation in all of its manifestations. Unlike a durational video, which is screened in a linear fashion similar to a conventional film showing with a beginning, middle and end that must be scheduled, video installations, if they do not feature a live television image, are most often constructed around a continuous and repeating set of moving image and sound sequences presented in a kind of stasis, making it possible to experience them in a similar way to sculpture, but with an additional repeating time-based element. The video installation was ideally suited to the traditional gallery or museum display and was easily accommodated within that well-established and respected format, while it was true that the phenomenon of “sound bleed” affecting the viewing experience in adjoining space could, and often was, an issue within many galleries.

## Contemporary Practice and Approaches: Some Examples and Tendencies

By the 1990s video art had become mainstream. No longer perceived as a marginal activity and now collected and displayed in museums and galleries, it had become ubiquitous, and was for many seen as almost the default medium for contemporary artists. Technological developments during the last decades of the twentieth century had made the medium reliable, accessible and commonplace—popular with both the museum and gallery venues and also artists interested in working with the moving image. The digital revolution had made video synonymous with film, rendering the two media effectively interchangeable and virtually inextinguishable from one another; the previous technical and aesthetic distinctions had become largely irrelevant. On a practical level, lower production costs combined with a multitude of distribution and dissemination methods and display systems brought about accessibility, acceptance and credibility. Video was everywhere—not just in galleries and art museums, but on multiple terrestrial and digital TV channels, projected or displayed on massive screens within and/or onto buildings, in offices and foyers, in shop windows and, perhaps most powerfully, available online. The internet opened up access to the moving image, not just for consumers, but also for those who wanted to make and show their work to anyone, anywhere, at any time. This inexorable transformation within a few decades from a marginal activity by a few “advanced” artists presenting their works in obscure, specialist viewing spaces to a medium for everyone simultaneously worldwide has completely transformed artists’ video. This technological revolution is not just at the display and processing end of things: perhaps equally profound is the revolution of the design and function of the recording mechanism; the video camera itself has evolved from a bulky container and protruding lens apparatus tethered by a thick umbilical cord to a recorder to become a self-contained, palm-sized, multipurpose imaging device that can fit into a shirt pocket. In many places in the world the smart phone is as ubiquitous as a pencil or pen. In fact this device does not simply replace the camera and recorder—it can be the entire means of production!

From its early tentative beginnings in Europe and the USA video art is now made by artists living, working and exhibiting everywhere and anywhere. It is shown in galleries and collected by museums, broadcast on television, purchased by private collectors and accessible—uploaded and even downloadable on the internet. The complex myriad of subgenres and formats that characterized video art from the very beginning has, since the mid to late 1990s, become even more diverse and less clearly definable. To identify someone as a “video artist” is often simply a convenient umbrella term to denote any artist who might be working in some way with moving image and sound within a fine art context.

To try to summarize such a vast range of creative output produced by so many artists in order to discuss and make sense of the array of attitudes, approaches and aspirations is beyond the scope of this article. However, to provide an idea of this diversity and scope, this section will outline some of the most prevalent and exemplary tendencies from the 1970s onwards and list a few of the key artists and practitioners engaged with each of them. It is important to stress that these are only examples and that individual categories are only indicative and should be understood as a starting point for further research, and perhaps, most importantly, that the boundaries between these categories are fluid: many artists, including the cross section of those referenced below, work across, against and between them.

*Multi-monitor/multi-screen*: This type of work is a variation of the most fundamental form of video art and expands beyond those who choose to employ a single screen, instead making use of multiple screens either of equal size or consisting of a mix of sizes and types. At its most basic a multi-monitor work could simply repeat a single image sequence across a number of screens or could instead present a mix of diverse or related imagery. Some of the earliest multi-screen works were derived from single-screen video tapes. Examples of artists working in this way include Woody Vasulka, John Sanborn, David Hall, Thierry Kuntzel, Steve McQueen, Tony Sinden, Catherine Ikam, Stan Douglas, Marcel Odenbach, Shirin Neshat, Jane and Louise Wilson and Yang Fudong.

*Installation*: Although a multi-screen video work could also be described as an installation, strictly speaking an installation contains other elements, objects and/or structures and therefore this type of work has sometimes been categorized as “Video Sculpture”. Some of the many artists working with this approach include Pipilotti Rist, Gary Hill, Julia Scher, Steina Vasulka, Judith Barry, Bill Viola, Douglas Gordon, Isaac Julien, Wang Gongxin and Wojciech Bruszewski.

*Mixed/multi-media*: A variation of installation, this type of work includes video imagery with other art forms, such as photography or sculpture. Artists known for this way of working include Wolf Kahlen, Elsa Stansfield, Madelon Hooykaas, Studio Azzurro—Fabio Cirifino, Paola Rosa and Leonardo Sangiorgi, Tina Keane, Tony Oursler, Diana Thater, Fabrizio Plessi, Kutlug Ataman, Vivan Sundaram and Guy Ben-Ner.

*Interactive*: Work of this type seeks to engage the spectator in an interaction with the content of the work. Although installations (see above) often require the visitor to explore the work and thus evoke a kind of physical engagement, interactive works take this a stage further, often employing touchscreen or other technological interfaces. Some examples of artists who have explored the potential of interactivity include Grahame Weinbren, Cory Arcangel, Jeffrey Shaw, Simon Biggs, Bill Seaman, Toshio Iwai, Ben Langlands and Nikki Bell.

*Internet (net art)*: This type of work is most often accessible online, but could also be a work that is derived from data or images from the internet displayed within a gallery context. Artists include John F. Simon Jr, Jennifer and Kevin McCoy, Mike Hentz, Susan Collins and Wolfgang Staehle.

*Virtual*: This type of work makes use of virtual imaging tools and is usually presented to viewers via special display devices such as VR headsets, providing viewers with an immersive experience. Some examples of artists who have developed virtual projects include Vibeke Sorensen, Ian Cheng, Shezad Dawood, Philip Hausmeier and Rachel Rossin.

## Conclusion

Although video was from the outset an electronic process, it was initially an analogue medium, with the electronic signal stored and retrieved magnetically. However, as techniques of digital image processing improved and computer systems became more efficient, more accessible and less expensive, video became increasingly digital. At first restricted to so-called “high-end” (i.e. television broadcast) post-production, with digital techniques mainly centred on the mixing and manipulation of the analogue video signal, by the beginning of the 1990s video had become almost entirely digital, from the images produced by CCD camera devices to the storage and processing right through to the distribution and dissemination of the final result. Additionally, the hitherto distinctly separate medium of film also succumbed to the digital revolution with a resultant convergence of the two rival mediums. By the end of the first decade of the millennium film and video seemed to have become indistinguishable. Certainly for many artists and audiences they were and are interchangeable. For curators and historians this has led to a certain amount of revisionary defining of the two previously very distinct genres. As a result of this converging technology, the back catalogue of “experimental film” and video art are often conflated or confused, with some significant films being categorized as video art, and some video artists perceived as filmmakers (and vice versa!). Although it is now less helpful to distinguish contemporary moving image work into one or the other genre, it is an arguably important and valuable criterion when tracing the history and context of the work and of the intentions, aspirations, political attitudes and aesthetics of the artists who made them.

Although the history of the medium in the primary and middle stages of its development and success is dominated by American artists and curators and to a lesser extent by artists based in Europe, by the beginning of the 1990s and into the new millennium artists’ video has become increasingly international and transnational, with artists from Asia, South America, the Middle East and from Africa and China. Video is now perceived as one of the most dominant and influential forms of contemporary art practice, and video in all its forms and formats is made, exhibited and seen across the world.

Video art had its beginnings as a new and distinct medium, born out of the development of a technology created to record and play back television sounds and images, taken up by radical artists and activists as a way of escaping the traditional mediums and ideologies of the established art gallery and museum and the monopolistic power of television broadcasters. From tentative beginnings in the 1960s it has gradually gained in popularity and acceptance by artists, curators and audiences alike to emerge as perhaps the most important and vital medium in contemporary fine art practice. No longer a distinct genre, it has evolved and matured, becoming hybridized and blended with other newer technology-based art forms.

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# Part 2: The Digital Age

The problem of our generation is to bring the intellectual and emotional, the social and technological components into balanced play; to learn to see and feel them in relationship.

— László Moholy-Nagy ([1947](#b-9781474207935-008-0000272): 12)

This article examines the multifaceted development of high-technology art during the mid-twentieth century. The artistic encounters with many different types of technology resulted in numerous unusual and experimental forms that embodied the driving force of the age. From the abstract animators and Constructivists a direct lineage could be traced to the mid-1970s and beyond.

The movement termed “Art and Technology” is synonymous with Experiments in Art and Technology (E.A.T.) founded by Billy Klüver and Robert Rauschenberg in 1967. It was also the name of Maurice Tuchman’s exhibition with LACMA in 1971 and informed other endeavours of the same period. The period of Art and Technology’s ascendancy was relatively short; however, the concepts underpinning it extend back to the beginning of the twentieth century, and its influence continues to be felt in the era of digital art.

“Art and Technology” tends to be applied as a historical label to a particular range of art collaborations with technologists, usually underwritten by large corporations, that flourished during the 1960s but ebbed away in the early 1970s as a range of concerns regarding ecology, consumerism and the role of advanced technology in warfare, especially the Vietnam War, came to the fore. Art and Technology was never a unified art movement as such, but many technological artists had a common source of inspiration in the Constructivists and Bauhaus. Their philosophy underpins many of the earlier experimenters in the field.

The separation between “fine art” and the technical arts and sciences began in the Renaissance, when practitioners of visual art sought to escape the lowly position accorded to manual crafts by classical and medieval philosophy. As the status of fine art was raised, this created a distinction with the fields of science and technology that were defined during the Enlightenment. “The conscious separation and classification of an activity or viewpoint as science, technology, or art is recent and came about rather slowly” ([Stanley Smith 1970](#b-9781474207935-008-0000328): 533).

Although artists engaged with materials and technologies that had a direct bearing on visual art, especially printmaking and etching, the mechanized world that emerged in Europe and North America during the Industrial Revolution was rarely regarded as a fit subject for high art. Indeed, many nineteenth-century artists consciously strove to repudiate or dismiss any sign of the rapidly industrializing world, exemplified in Ruskin’s writings, and this led to a perception that the visual arts were hostile to the intrusion of mechanized technology into their domain.

In responding to the industrial and post-industrial world, many commentators ascribed sweeping powers to an ill-defined notion of “technology”, leading to an overly determinist or despairing view. For instance, Arthur Efron contradicted Marshall McLuhan’s idea that technology could act as an extension of the human body, on the basis that human experience is delimited by the body. He suggested that instead of being immersed in technological determinism, one should instead disengage and withdraw from an engagement with technology itself ([Efron 1966](#b-9781474207935-008-0000159): 684).

Observing this tendency to regard “Technology” as monolithic, the French cultural historian Pierre Francastel claimed that “abstractions like Art, Society, Machine and Technology [are treated] as attributes of man in the absolute” ([Francastel 2000](#b-9781474207935-008-0000174): 85). He also noted there is a technical aspect to all human activities, and that technique “is not an autonomous function. In certain respects, science as well as art or philosophy is a technique in the broadest sense of the term” (ibid.: 270).

The British writer, and scientist, C. P. Snow claimed there was a “gulf of mutual incomprehension” between the sciences and arts in his Rede Lecture of May 7, 1959, “The Two Cultures”. Snow articulated the belief that the humanities in the modern era were, to some degree, inherently anti-scientific and thus anti-technological ([Snow 1960](#b-9781474207935-008-0000322): 4). Although Snow was later accused of exaggeration, he put his finger on a basic distinction that still causes problems today, despite repeated attempts to foster interdisciplinary work. His contentious division between these two areas helped define the post-war cultural consensus in a way that surely undermined his intentions, but it also inspired some of the earliest attempts to consciously combine art and high technology. Snow himself later retreated from this position, looking to the possibility of a “third culture” to bridge the gap ([Snow 1964](#b-9781474207935-008-0000325)).

Other theorists of the time were convinced that the anti-technological orientation of many public intellectuals was retarding an understanding of the meaning of these new technologies and their impact on culture. Lawrence Alloway, one of the members of the Independent Group at the centre of the British Pop Art scene that presciently noted Cold War consumerism, averred that humanists had failed to keep their grip on public values due to “their failure to handle technology, which is both transforming our environment and, through its product the mass media, our ideas about the world and about ourselves” ([Alloway [1959] 1988](#b-9781474207935-008-0000102): 33).

The journal *Leonardo*, founded by scientist and artist Frank Malina in 1967, was also in many ways a reaction against Snow’s idea of an unbridgeable dichotomy between the arts and sciences. The artists and technologists who provided the impetus for Art and Technology, especially Robert Rauschenberg and Billy Klüver, also responded to such perceptions of technology as an invasive force into the art world. In so doing, they developed an aesthetic application of science and advanced technology in order to create novel visual forms, particularly interactive works of novel form, and considered the societal implications of their activities.

These changing views of the roles of art and technology were themselves subject to wider societal changes and underpinned by the Second Industrial Revolution (circa 1870–1914), where electricity and internal combustion engines gradually displaced steam motive power, and the nascent Third Industrial Revolution of information technology. “The positive and negative visions of technological progress share many common assumptions. Both assume that modern technologies pose an unprecedented challenge to the arts” ([Winston 1987](#b-9781474207935-008-0000345): 190).

## The Underlying Technological Context

The impetus towards an experimental field of Art and Technology emerged from wider trends in the major industrial countries after the Second World War, in particular the USA, Central and Eastern Europe, and to some extent Japan and Latin America. The convergence of several aspects made Art and Technology possible.

Entirely new fields such as computing, satellite telecommunications, broadcast media and space exploration gave a visibility and dynamism to the technological sector from the 1950s onwards that entered popular culture on many levels. Despite the urgency of the early Cold War, there was a generally optimistic current of progressive thought exemplified in the futuristic visions displayed at the World’s Fairs, at least until the mid-1960s. Bold predictions about a technologically advanced society, buoyed by the Space Race, also boosted the status of Art and Technology. Yet the underlying paranoia fostered by the indirect confrontations between NATO and the Warsaw Pact, and the rapid advances in nuclear delivery systems that culminated in the Cuban Missile Crisis, resulted in an outwardly prosperous consumer society (in the Western nations at least) that was also increasingly aware of its precarity in the face of nuclear warfare ([Gere 2006](#b-9781474207935-008-0000188): 92–3).

In a purely pragmatic sense, the proliferation of consumer electronics and military surplus equipment brought these new techniques within the reach of artists. The more naïve aspects of “Art and Technology” involved the uncritical deployment of these advances in high-art settings. In 1966, the scope of these discoveries was summarized by Brian Dennis:

If technology has opened up new areas in the discovery of musical sounds, synthetic materials have also provided inspiration for much experiment in the visual arts. Plastics, alloys and other related materials are being used to construct ‘paintings in relief’ …. Kinetic art and the use of machinery in the animation of these works adds the dimension of time to a hitherto static art.

— ([Dennis 1966](#b-9781474207935-008-0000154): 19)

Another factor that also related to the expansion of wartime industries and the increasing technological level of the military was that a broad section of the public had direct experience with advanced technology including several influential artists who passed through the aviation industry. This ensured an element of familiarity with technology among artists and their audiences.

The economic boom in the USA from the late 1940s, followed by Western European and some East Asian economies, encouraged the support and patronage of technological art by various corporations and state bodies. Museums such MOMA and the Institute of Contemporary Art had a remit to capture the Zeitgeist. The exhibition of contemporary works in museums was a recent innovation in itself, thus Art and Technology benefitted from a supportive climate. Moreover, the corporations that developed high technology craved the prestige that came with supporting the arts. As Gustav Metzger noted in 1969, this patronage brought with it the association with large corporate interests: “Technological art is kinetic art plus a lot of money. Whereas kinetic art can be produced by the artist in his studio, technological art depends on direct contact with industry and research laboratories. … technological art inherently tends towards obsolescence” ([Metzger 1969](#b-9781474207935-008-0000267): 107).

Although the culture around Art and Technology tended to be celebratory rather than critical, especially in the major exhibitions, artists such as Metzger were cognizant of the destructive aspect of technology. Alongside the threat of atomic annihilation, the effects of mass industrialization, pollution and environmental problems became more widely discussed in the late 1960s. By the mid-1970s, technological art was increasingly associated with the military-industrial system symbolized in America and elsewhere by the debacle of Vietnam.

The economic downturn of the early 1970s, combined with global social unrest and the end of the Apollo lunar programme, is perceived as the conclusion to the large-scale programmes of artistic engagement with technology. This coincided with the rise of video art, which focused on a widely available and visually oriented format that did not depend on the large museums and corporate funding that underwrote Art and Technology. It flourished under the patronage of prescient curator Howard Wise, who saw the potential of using television as an art medium and supported pioneering video artists by founding Electronic Arts Intermix in New York ([Wise 1969](#b-9781474207935-008-0000350)).

## **Machines in Art Before** **1950**

The visual arts have historically been less receptive to the use of machines than the field of music. Since Pythagoras, the notes of the scale have been linked with numbers and could be expressed in numerical form. Mechanical instruments such as the organ, the player piano and the theremin were all incorporated into the range of musical practice soon after their invention. This is probably because music, or at least tonal value, is easier to define in mathematical terms than visually complex images.

Several theorists in the Renaissance, notably the polymath Athanasius Kircher, developed automatic music composition systems as well as self-playing instruments that also produced visual effects using water-powered mechanisms. In his volume *Musurgia Universalis*, Kircher looked forward to the development of a combinatorial musical system ([Godwin 2015](#b-9781474207935-008-0000191): 172). Kircher was also involved in the development of the magic lantern and took an interest in optical projection ([Grau 2003](#b-9781474207935-008-0000194): 280). Nearly two hundred years later, during her consideration of Charles Babbage’s Analytical Engine, Ada, Lady Lovelace conjectured that if harmony and composition could be properly defined, “the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent” (quoted in [Holtzman 1994](#b-9781474207935-008-0000209): 159).

It is unsurprising, therefore, that the first area of visual art that became amenable to mechanical devices was the liminal area of “visual music”, with attempts to link colour and music, usually by means of elaborate mechanical apparatus. With influences from Newtonian colour theory and the likely influence of synaesthesia on several of the pioneers in this area (Bainbridge, Wallace Rimington and others who were active between 1880 and 1910), several “colour organs” were constructed that used newly available electric lights in conjunction with more traditional keyboard layouts to activate sequences of colour in sympathy with various musical themes. This presaged the incorporation of mechanical and industrial processes into art that began in earnest at the turn of the twentieth century ([Lambert 2003](#b-9781474207935-008-0000237)).

Perhaps the best-known of these synaesthetic experimenters is the Russian composer Alexander Scriabin. Scriabin increasingly sought to fuse image and sound towards the end of his life, scoring the symphony *Prometheus* for orchestra and a “light keyboard”, Tastiera per luce, that premiered in 1911. He engaged a professor of electro-mechanics, Alexander Moser, to construct the Tastiera, and devised a system of correspondences between notes on the musical scale and his own colour perceptions, which would then be projected by the keyboard as its operator followed a musical score alongside the orchestral performance ([Bowers 1974](#b-9781474207935-008-0000117): 82 and 191). However the actual machine broke down before the initial Moscow performance, and only in 1915 was *Prometheus* first performed with coloured lighting at Carnegie Hall. The light-machine score was lost until its rediscovery late in the twentieth century but has been reconstructed for recent performances.

Scriabin was serious in his aim to converge music and colour, and thereby achieve the *Gesamtkunstwerk*; he did not wish to be remembered merely as a “musician”. He also wanted to go beyond the personal associations of synaesthesia and achieve a universal system for colour music ([Peacock 1985](#b-9781474207935-008-0000289): 484).

Marinetti’s article “The Founding and Manifesto of Futurism”, published on the front page of *Le Figaro* on February 20, 1909, announced the arrival of a new movement, dedicated to overthrowing old aesthetic standards and embracing the Promethean promise of advanced technology:

We will sing of great crowds excited by work, by pleasure, and by riot; we will sing of the multicolored, polyphonic tides of revolution in the modern capitals; we will sing of the vibrant nightly fervor of arsenals and shipyards blazing with violent electric moons; … and the sleek flight of planes whose propellers chatter in the wind like banners and seem to cheer like an enthusiastic crowd.

— ([Marinetti 1909](#b-9781474207935-008-0000258))

Although the Futurists were primarily concerned with the depiction of motion and motive power, several artists from this movement (especially Luigi Russolo) and the contemporary Dadaists engaged with mechanical elements in their art. Georges Antheil, whose “Ballet Mechanique” prefigures many later kinetic works, recorded his work on film and the system itself was rebuilt many years later. European émigré artists also noted the significance of machinery in early twentieth-century America, and Francis Picabia attempted to derive a “machinist” style of hard-edged precision to reflect the symbolism of the machine: “I have been profoundly impressed by the vast mechanical development in America. The machine has become more than a mere adjunct of life. It is really part of human life … perhaps the very soul” (Picabia quoted in [Camfield 1966](#b-9781474207935-008-0000139): 313).

An early theorist of mechanical devices in visual art was the musicologist Joseph Schillinger, who connected mathematics with musical composition and visual form. Basing his system on principles of engineering and design, Schillinger foresaw a time when machines might be able to create art independently and invented several categories in which they could function: “Mechanical realization of this method is a natural consequence. Various instruments may be constructed for the automatic production, reproduction, and variation of works of art. Instruments of the analyser type may also be constructed for the automatic testing of the esthetic quality of works of art” ([Schillinger 1948](#b-9781474207935-008-0000304): 673). He proposed, among other instruments, a device called the “Artomaton”, which could produce linear designs (“Graphomaton”) or designs using projected light (“Luminaton”), and others for kinetic displays and theatrical productions. Like Vannevar Bush’s Memex ([Bush 1945](#b-9781474207935-008-0000134)), which prefigured the computer’s database and hyperlinking capabilities in analogue form, Schillinger’s concepts seem to articulate many functions that were first built into analogue, then digital, sound and visual machinery.

Schillinger was influential in several areas; he was an associate of Leon Theremin, another Russian émigré, and encouraged the development of several electronic instruments including an early drum machine for musicologist Henry Cowell. Via Cowell, Schillinger influenced John Cage; and Schillinger’s collaborator Mary Ellen Bute utilized his theories in her abstract animations set to music. Indeed, Bute’s animations were widely seen across the USA during the 1930s and 1940s, as she and other animators created a synaesthetic medium that was not viewed as “Art and Technology” per se ([Moritz 1996](#b-9781474207935-008-0000281)). After the Second World War, the brothers John and James Whitney utilized a military surplus analogue computer to automate the production of abstract animation, pointing the way towards digital imagery.

Another key figure in the development of mechanically realized visual art was Thomas Wilfred, a Danish-American artist and inventor who established the Art Institute of Light on Lexington Avenue, New York, in the early 1920s. Here he developed a purpose-built colour lighting system that projected abstract forms on a huge screen, a light performance controlled from a switchboard that also informed Mary Ellen Bute’s understanding of co-ordinating images and music. Wilfred conceived of the screen as a space upon which “a three-dimensional drama” could be created using “a specially constructed projection instrument controlled from a keyboard”, an art form he referred to as “lumia” ([Wilfred 1947](#b-9781474207935-008-0000340)). Unlike many of his contemporaries, Wilfred always intended that the performances should be silent, the images being composed in a way analogous to music but without an accompaniment ([Lambert 2019](#b-9781474207935-008-0000249)).

Wilfred influenced artists who visited the Art Institute of Light—it is reputed that Jackson Pollock was one of them—and his profile was significant enough that in 1971 MOMA staged a retrospective of Wilfred’s work featuring lumia compositions and drawings. Thirty years previously, the museum had purchased Wilfred’s *Vertical Sequence II, Opus 137*, the first of his works to enter a museum collection, and in 1952 included him in an influential show, “15 Americans”. He also built a domestic version of his light system, the Clavilux, in limited quantity during the 1930s, and several of these machines survive in working order ([Eskilson 2003](#b-9781474207935-008-0000164): 65).

Around the time that Wilfred was establishing himself in New York, artists were experimenting with kinetic sculptures, including Naum Gabo, whose *Kinetic Construction (Standing Wave)* of 1919–20 used a motor to rapidly oscillate a metal rod into a standing wave of apparently three-dimensional form. It connected with Gabo’s Constructivist and revolutionary aspirations expressed in his *Realistic Manifesto* of 1920, against the backdrop of the 1917 Communist Revolution that abolished Imperial Russia and established the USSR. The Constructivist artists engaged with the transformative impact of new technology that accompanied the revolution, and they wanted to make art that was relevant to new industrial processes and techniques. The piece was intended as a demonstration of kinetic form into sculpture and became a seminal work of kinetic art. Half a century later, Gabo permitted Pontus Hultén to make a replica for his MOMA exhibition “The Machine, as Seen at the End of the Technological Age” ([Hultén 1968](#b-9781474207935-008-0000212): 106), and wrote a reminiscence for *Studio International* ([Gabo 1969](#b-9781474207935-008-0000183): 89).

Although Gabo returned to making static sculptures, the revolutionary ferment of Constructivism inspired the foundation of the Bauhaus school of design in Weimar and its founder Walter Gropius’s slogan “Art and technology—a new unity”. The Hungarian artist László Moholy-Nagy made the most sustained engagement with emerging technologies throughout his career, for instance presaging the use of remote production in his *Telephone Paintings*, where he claimed to have directed a sign-factory supervisor by telephone to design enamel panels to his specification, thereby questioning the role of the artist’s hand in the making of a work. With this method, his artistic input became part of a quantitative arrangement of formal elements, precisely described by the colour system and the dimensions he was using. As such, he was specifying the art and directing others to make it; his method introduced an element of artistic anonymity ([Kaplan 1995](#b-9781474207935-008-0000215): 122).

More so than many of his contemporaries, Moholy-Nagy grasped the inherent potentials of the dynamism and materials provided by new technologies; rather than the spectacle provided by Futurism, he saw their fundamental uses. When Nazism forced him to leave Germany, he set up the New Bauhaus in Chicago in 1937 and incorporated the exploration of material and process into its curriculum. Indeed, he expanded on Gropius’s statement to make the curriculum work around “Art, Science and Technology”, incorporating photography, film and kinetic sculpture, along with life sciences ([Findeli 1990](#b-9781474207935-008-0000169): 7). In this way he bridged European and American approaches to incorporating art and technology prior to the Second World War, and although he died in 1946, books such as *Vision in Motion* and the efforts of his wife Sibyl perpetuated his work into the post-war era and ensured that his concepts continued to be influential.

His most direct successor was Gyorgy Kepes, founder of the Center for Advanced Visual Studies at MIT in 1967, where artists such as Stan Vanderbeek developed directions in the use of film and communications technology ([Lambert 2013](#b-9781474207935-008-0000239): 43). Kepes explicitly stated that CAVS was a continuation of the Bauhaus approach to science, engineering and art, and was intended to provide a point of interaction between practitioners and disciplines ([Collins Goodyear 2004](#b-9781474207935-008-0000144): 618).

Another important transference between the European and American concepts of Art and Technology occurred in 1937 in the brief encounter between the young John Cage and the abstract animator Oskar Fischinger. Having left Germany following the rise of Nazism, Fischinger was based in Los Angeles from 1936 and worked on the animation for Walt Disney’s *Fantasia* while developing his own short films. He utilized frames that moved visual elements on painted glass to create complex layered effects, and employed Cage to assist with this stop-motion filming. Fischinger’s belief in the “spirit inside each object”, a concept that everything had animate form that could be released, left a deep impression on Cage, as did his approach to making art with mechanical apparatus. Prior to this, Cage had also been involved in the experimental work carried out by his father, John Cage Sr, in early television and radar apparatus that informed his later interest in electronic music ([Brown 2012](#b-9781474207935-008-0000123)).

## Kinetic Art

After the Second World War, there was a growing interest in kinetic art in Europe, especially in France, where Frank Popper was involved in exhibiting the increasing number of artists using machines in their work. Popper believed kinetic art was the continuation of the need to express dynamic, often mechanical, forms in art through the animation of physical objects:

If art in this century reveals a trend toward the evocation of the image of dynamism as exemplified by such movements as the Futurists, then we searched for a genuine art of movement ….Time and space, the talisman of this century for both the arts and the sciences, have actually received less than lip service from the plastic artist.

— ([Popper 1966](#b-9781474207935-008-0000294): 6)

One of the earliest kinetic exhibitions was “Le Mouvement” in 1955 at the Galerie Denise René, featuring works by Yaacov Agam, Pol Bury, Alexander Calder, Marcel Duchamp, Robert Jacobsen, Jesús Rafael Soto, Jean Tinguely and Victor Vasarely. Calder’s Mobiles and Duchamp’s Rotoreliefs were important to the early development of kinetic art, as was the work of Liliane Lijn.

Kinetic art shares its dynamic aspect with abstract animation. Underpinning both art forms is the inherent fascination of seeing a mechanism working apparently unaided to produce images that seem to be the product of another mind, or at least spring from an independent process. Later, the video artist Steina Vasulka articulated this fascination with time, motion and mechanisms as follows: “I remember discovering those things like gears and DC motors as some kind of a great mystery and a miraculous thing and I find it very close to life. A mechanistic replication of the biological mystery” ([Weiss and Sumner 1992](#b-9781474207935-008-0000336): 3).

Frank Malina, in his edited volume on kinetic art published through *Leonardo* in 1974, listed the main approaches that were deployed by kinetic artists in their works: “1. Pictorial and sculptural objects incorporating motion and changes of colors with time; 2. Objects in which changes with time are random, programmed or responsive; 3. Visual experiences provided by slide projection, cinema and television techniques” ([Malina 1974](#b-9781474207935-008-0000255)).

There was also some overlap with the group Fluxus, especially in terms of a more free-form approach to technology exemplified by Nam June Paik and Dick Higgins, who coined the term “intermedia” to encapsulate the breakdown between mediums that he observed in the Happenings of the 1960s. Seeing the divisions between art media as an outmoded social construct of the Renaissance, Higgins said: “Part of the reason that Duchamp’s objects are fascinating while Picasso’s voice is fading is that the Duchamp pieces are truly between media, between sculpture and something else, while a Picasso is readily classifiable” ([Higgins 1966](#b-9781474207935-008-0000204)).

## Cybernetics

While kinetic art developed along its own trajectory, a major conceptual influence on Art and Technology came through the transdisciplinary scientific theory of cybernetics. Norbert Wiener proposed the concept of cybernetics as a new area of scientific investigation, in *Cybernetics: Or Control and Communication in the Animal and the Machine* published in 1948. One of the first artists to respond to the concept of feedback was the Hungarian Nicolas Schöffer, whose mobile sculptures responded to light patterns that activated certain behaviours. His concept of “Spatiodynamics” emerged in 1954: “[A] homeostat … realizes a total synthesis between sculpture and sound … with a maximum of flexibility, because it immediately adapts to every change” ([Schöffer 1954](#b-9781474207935-008-0000307)). This led to the development of *CYSP1* in 1956, commissioned by the Philips Corporation, a mobile interactive sculpture that used light sensors to trigger its movement and which became part of a performance with dancers.

As a student, Roy Ascott visited Schöffer in Paris through a scholarship provided during his Fine Arts course at Newcastle University, where his tutors included Victor Pasmore and Richard Hamilton ([Lambert 2017](#b-9781474207935-008-0000244): 40). Hamilton’s work with the Independent Group for the Festival of Britain, and his subsequent practice, engaged with scientific imagery and technical themes emerging from Moholy-Nagy, alongside American consumer culture that found expression in British Pop Art; and it was architect Reyner Banham who introduced cybernetic theory at a meeting of the Independent Group in 1955 ([Massey 1995](#b-9781474207935-008-0000264): 91).

John McHale and Hamilton also collaborated on the Whitechapel Art Gallery show “This Is Tomorrow” in 1956, where the themes of technology and art included the first mention of data processing ([Mason 2008](#b-9781474207935-008-0000261): 28). The cybernetic pioneer Gordon Pask developed his interactive Musicolour system in 1953, using feedback to engage dancers in a “conversation” ([Haque 2007](#b-9781474207935-008-0000197): 56). Ascott synthesized cybernetic principles from Ross Ashby and F. H. George that influenced his *Change Paintings* and provided the basis for his Groundcourse at Ealing College of Art, and subsequent developments that impacted British fine art pedagogy ([Shanken 2002](#b-9781474207935-008-0000316): 169–70).

The terminology of cybernetics provided an interface for certain artists to engage with a contemporary scientific movement and prepared the ground for later collaborations in large-scale art and technology artworks. Indeed, as Jasia Reichardt, curator of the groundbreaking “Cybernetic Serendipity” exhibition at the ICA, noted later: “The 1950s were a crucial decade for setting up [things that happened] in the 1960s; there was an undercurrent of excitement with many genuinely new ideas” ([Reichardt 2014](#b-9781474207935-008-0000303)). Reichardt herself was first introduced to cybernetics in September 1957, at a talk at the Gaberbocchus Common Room, a salon run by her uncle and aunt, the Themersons, to facilitate art and science discussions. From then onwards, she followed the development of kinetic art in the UK and abroad and went to America to visit the founders of Experiments in Art and Technology.

Ascott expounded the key concepts of cybernetics in these terms: “The machine, largely self-regulating and highly adaptive, stands between man and his world. It extends his perception into furthest space and deep into the finest particles of matter …. Cybernetics is not only changing our world, it is presenting us with qualities of experience and modes of perception that radically alter our conception of it” ([Ascott [1964] 2003](#b-9781474207935-008-0000108): 102). However he developed the conceptual rather than technological side of cybernetics in subsequent work.

## The Apex of “Art and Technology”

A key locus of experimentation in Art and Technology was Bell Telephone Laboratories, located in Murray Hill, NYC. The scope afforded to researchers there enabled the emergence of large-scale corporate-supported technological artworks. It also provided the template for later laboratories such as Xerox PARC in Palo Alto that had artists in residence, if on a smaller scale. The corporate rationale for creative engagement was the potential for problem solving and innovative technologies emerging from collaborations; and several of the earliest computer artists (Michael Noll, Kenneth Knowlton and Lillian Schwartz) either worked at or collaborated with Bell Labs ([Noll 1994](#b-9781474207935-008-0000284): 39).

The Swedish engineer Billy Klüver was working at Bell Labs in early 1960 when Jean Tinguely was setting up his self-destructive kinetic sculpture *Homage to New York* at MOMA, which had been commissioned by its chief curator Peter Selz. Klüver worked as Tinguely’s technology consultant and assisted him in locating scrap parts. Intended as commentary on the mechanized metropolis, *Homage* caught fire prematurely and was extinguished, to the amusement of some contemporary critics. Klüver was inspired by the experimental nature of the collaboration to develop further projects utilizing the experimental technologies at Bell Labs, and he partnered with Robert Rauschenberg (who also contributed to *Homage*) to set up an exhibition. Klüver’s key insight was that “engineers themselves could be the materials for the artists …. The way I see it is that artists provide non-artists—engineers or whomever—a certain number of things which non-artists do not possess” ([Hertz 1995](#b-9781474207935-008-0000202)). However, Klüver did not perceive this to be within the scope of Kepes’ continuation of Bauhaus ideals at MIT but rather a new manifestation emerging from the contemporary art of the 1960s ([Collins Goodyear 2004](#b-9781474207935-008-0000144): 625).

The first result of his artist and engineer collaboration was “Nine Evenings: Theater and Technology” at the New York Armory in 1966. The event was supported by Bell Labs technicians and brought together key figures from the visual and performative arts: Rauschenberg, John Cage, David Tudor, Yvonne Rainer, Deborah Hay, Robert Whitman, Steve Paxton, Alex Hay, Lucinda Childs and Öyvind Fahlström. Novel technologies included fibre-optic cameras, infra-red sensors, wireless FM transmitters and amplifiers. The audience was plunged into darkness, left waiting as technical problems were resolved, but occasionally the exhibits went as planned. This led to much negative press and suggestions that Klüver’s collaboration was undermined by his insistence on artist-led projects that asked too much of the technology ([Brockman 1966](#b-9781474207935-008-0000120)). Nonetheless, Klüver always defended his approach to collaborations: “It is not a question of what the artist *should* do, but what he *will* do with technology. Whether technology is good or bad, threatening or friendly, beautiful or ugly is irrelevant” ([Klüver 1967](#b-9781474207935-008-0000230): 30–31).

“Nine Evenings” enabled Klüver and Rauschenberg to found an organization dedicated to supporting more collaborations of this type: Experiments in Art and Technology. Its best-known large-scale project was the light and sound installation at the Pepsi Pavilion at the Osaka World’s Fair in 1970. E.A.T’s *raison d’etre* was that the emerging technological world needed the artist’s experimental ethos:

The large interest on the part of the artist and the enormous difference between the worlds of the arts and technology has made it clear that a goal of E.A.T. must be to provide the artist with a permanent and organic access to the technical world. Conversely, E.A.T. will work for a situation where the engineer will find himself at home with artists.

— ([Klüver and Rauschenberg 1967](#b-9781474207935-008-0000235): 2)

Klüver’s attempt to bridge the gap certainly acknowledged this “separateness”; yet by privileging the artist, he seemingly ignored the creative input from the engineer. Later, the computer artist Lillian Schwartz noted that scientists appeared to be trespassing on artists’ turf—and vice versa: “Conflicts arose between the artists and the scientists, and just as some of the scientists declared that they were artists, some of the artists claimed substantial scientific knowledge” ([Schwartz and Laurens 1992](#b-9781474207935-008-0000313): 9).

The late 1960s saw a plethora of collaborative exhibitions, including: “The Machine as Seen at the End of the Mechanical Age” curated by Pontus Hultén at MOMA from November 1968; “Cybernetic Serendipity” curated by Jasia Reichardt at the Institute of Contemporary Art in London, 1968; Jack Burnham’s “Software” at the Jewish Museum in New York in 1970; and the highly ambitious Art and Technology programme at the Los Angeles County Museum of Art, 1967–71, under Maurice Tuchman ([Tuchman 1971](#b-9781474207935-008-0000333)). It should be noted that all the institutions hosting the exhibitions had an ethos that encouraged engagement with contemporary art forms.

“Cybernetic Serendipity” combined popular success, in terms of audience numbers, with significant influence on subsequent artistic engagement with technology, especially the nascent area of computer art. Reichardt’s show ran from August to October 1968, followed by Washington DC and San Francisco in 1969. A key contrast with Klüver’s approach to E.A.T. was that Reichardt did not distinguish which of the works were made by artists and which by scientists and engineers. “Cybernetic Serendipity” had over 300 participants and was seen by 60,000 people.

The exhibits … consisted of computer graphics, computer composed and -played music, computer-animated films, computer texts, and among other computer generated material, the first computer sculpture. … Two aspects of this whole project are particularly significant. [At] no point was it clear to any of the visitors walking around the exhibition, which of the various drawings, objects and machines were made by artists and which were made by engineers.

— ([Reichardt 1971](#b-9781474207935-008-0000300): 11)

Of the established art publications, *Studio International* provided significant coverage to art and technology, giving a regular column to anthropologist Jonathan Benthall to cover the latest developments, also inviting contributions from Gustav Metzger and Monique Fong among others. Benthall closely followed the British scene and engaged with work from America and Eastern Europe, and drew attention to the New Tendencies conferences in former Yugoslavia. He also covered the first exhibition of the Computer Arts Society in 1969.

## New Tendencies

The post-war Art and Technology movement in anglophone countries had developed with inputs from many European émigrés acting as a bridge between the pre-1940 avant-garde and the post-war West: Moholy-Nagy, Fischinger, Klüver, Reichardt, Metzger and many others acted as interlocutors between the continental and Anglo-American art scenes.

Despite the human and material impacts of the Second World War and the division of Europe between the victorious powers in 1945, new directions in European art and technology emerged through kinetic art and later cybernetics. One of the most sustained critical and theoretical forums for science and technology in art was the New Tendencies (NT) conferences and exhibitions in Zagreb, later the subject of a major retrospective at the ZKM in Karlsruhe in 2008–9, “bit international. [Nove] tendencije” (Rosen 2010).

The original New Tendencies exhibitions were organized by the Galerija suvremene umjetnosti (Gallery of Contemporary Art) between 1961 to 1973, with further exhibitions in Paris, Venice and Germany. Because of Yugoslavia’s role as a Non-Aligned socialist nation outside the major Cold War groupings of NATO and the Warsaw Pact, the New Tendencies group included artists, theorists and curators from a wide area of Europe and Latin America, and later Japan, the USA and USSR ([Fritz 2010](#b-9781474207935-008-0000177): 32).

A key difference between the large-scale exhibitions organized in the West and New Tendencies was the latter’s willingness to debate and engage with the political ramifications of technological and artistic interactions ([Klütsch 2005](#b-9781474207935-008-0000218)). Indeed, many contributors to NT welcomed the use of industrial techniques in art, with a view to undermining the cult of the object and the value placed upon uniqueness. The Croatian art theorist Matko Meštrović took an ideological stance on the “synthesis of science and art, within the framework of rendering humanities and art more scientific, as part of the long-term utopian process of the overall rendering of all human activity into science” ([Fritz 2010](#b-9781474207935-008-0000177): 33).

By the late 1960s, NT focused more fully on computer art and cybernetic processes. Germany and other parts of Central Europe had seen the early development and theorization of computer art due to the Information Aesthetics theory advanced by Max Bense and his students at Stuttgart ([Klütsch 2012](#b-9781474207935-008-0000224): 67). Although New Tendencies was important in its later stages for the pioneering computer work undertaken by its artists and curators, between 1962 and 1967 it aimed to define experimentalism in art, and therefore the artist’s progressive role as a radical innovator. Central to this vision was the deployment of contemporary materials and techniques; it was the artist’s duty to engage with new technologies and understand their rational and scientific basis ([Molnár and Morellet 1965](#b-9781474207935-008-0000275), quoted in Rosen 2010: 139).

## Conclusion

The “Art and Technology period” is usually bookended by the exhibition “Software” at the Jewish Museum in NYC in 1970 and “Art and Technology” in Los Angeles in 1971. The fading of Art and Technology dovetails with the Vietnam protests, the rise of the ecological movement and a shift towards a more conceptual art that preferred not to engage with cogs and wires. Jack Burnham’s piece “The Panacea That Failed” (1985) is the movement’s epitaph ([Burnham 1980](#b-9781474207935-008-0000128)). Moreover, the intentions of collaborations such as “Art and Technology” at LACMA were undermined by scepticism both on the part of artists and engineers in the collaborations: “When ‘Art and Technology’ opened in May 1971 at LACMA, only sixteen collaborations had come to fruition, although seventy-six artists were listed as ‘participating’” ([Collins Goodyear 2008](#b-9781474207935-008-0000149): 171).

As Jonathan Benthall remarked in his comprehensive survey of technological art: “Society as a whole is beginning to subject its entire technological apparatus to ecological scrutiny, and also the alleged objectivity of science to socio-political scrutiny” ([Benthall 1972](#b-9781474207935-008-0000114): 13). There was increased awareness of environmental destruction as a result of industrialization, and corporate profiteering from the Vietnam War and other conflicts across south-east Asia, southern Africa and Latin America. Although there continued to be networks of artists working with industry, such as the Artist Placement Group founded by John Latham in the UK, there was also less support forthcoming from companies that perceived few public relations benefits accruing from working with artists.

Arts–science collaborations continued at a smaller scale and were documented in the journal *Leonardo*, whose founder, scientist and kinetic artist Frank Malina, wanted to provide a forum for this convergent area. In this context, the growth of telematic and interactive art in the 1970s, using new digital networks that would eventually coalesce into the internet, was an important factor.

Despite the failure of the grand Art and Technology projects, several technology-defined disciplines emerged, of which video art received most attention and prominence after 1970. Initially centred on Electronic Arts Intermix in New York and subsequently through artists such as Peter Weibel, the movement gave rise to the Ars Electronica festival at Linz in 1979. This became the international locus for artists using the emerging medium of digital imagery and supported the field with annual prizes. The foundation of the Zentrum für Kunstmedia (ZKM) in Karlsruhe, Baden-Württemberg, in 1989 as an “electronic Bauhaus” by Heinrich Klotz, provided an international museum and research centre that connects back to the ethos of Gropius and Moholy-Nagy.

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What business has an artist in critiquing the rhetorics of computing and artificial intelligence? This is a question I might have been asked in 1987 when I published my first essay on the subject, entitled ‘Simulation, Digitization, Interaction: The Impact of Computing on the Arts’ ([Penny 1987](#b-9781474207935-009-0000168)). As indicated by this title, my preoccupation as an artist was (and would be for the ensuing two decades) with the phenomenon of real-time computing as a new technological context that afforded a new kind of aesthetic engagement. I wanted to build systems that were *lively*, not *life-like* in an anthropomorphic or biomorphic sense (animatronics and similar pursuits always seemed theoretically naïve to me). I wanted to make *designing* *behaviour* a central part of my work, and the experience of “life-like” behaviour to be central to the experience of the work. My key concern was to prototype the behaving artwork, and to explore the “aesthetics of behaviour” (as such, questions of imagery, so central to much “new media art,” sometimes felt like a distraction). (Documentation of such works, including *Petit Mal*, *Fugitive* and *Traces* can be found at simonpenny.net.)

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Such a remit would, one might assume, predispose one to embrace the agendas of conventional AI, a topic of much public interest and concern, then as now. In my case the opposite was true. I never drank the AI Kool-Aid. I was under no misapprehension that computers would achieve human-like cognition, in my lifetime at least, if ever. I still believe this, and I find arguments to the contrary vapid. Neither was I under any misapprehension that the computational behaviours of my (or any) systems constituted life or living. This position relates to a key debate in the artificial life movement that succeeded (the collapse of) first-generation artificial intelligence in the late 1980s. In the AI community, there was a distinction between “Hard AI” and “Soft AI.” Hard AI asserted that AI was intelligence; Soft AI held that AI was only simulated intelligence. A similar distinction was made in Artificial Life circles in the 1990s, between Hard A-Life (digital “life forms” were alive) and Soft A-Life (digital systems simulated some of the qualities of living systems). My pursuit of *liveliness* using computational systems provided me a perspective from which to critique discourses of artificial intelligence and of cognition that have informed my critical enquiry ever since ([Penny 2017](#b-9781474207935-009-0000179)).

In the second-order cybernetic sense captured succinctly by Humberto Maturana when he quipped “everything said is said by an observer” ([Maturana 1987](#b-9781474207935-009-0000152)), liveliness (contrary to more recent neo-materialist theory) is an attribution applied by someone who has an experience. I saw my task as building a technological infrastructure to facilitate such experience, utilizing real-time computational technology that was reactive, based on real-time sensor data. As a result, perhaps, of my training in sculpture and my prior practice in performance and installation, the interactive installations I built always involved active, embodied participation by the party formerly known as “viewer” or “audience,” whom I came to refer to, using Augusto Boal’s neologism, as a *spectactor* ([Boal 1985](#b-9781474207935-009-0000100)). In my work, the spectactor acts, the work responds, in an ongoing interaction I referred to as a “conversation.” It hit me as an epiphany in the mid-1990s that this mutual interaction destabilizes the conventional aesthetic calculus based on the notion of *contemplation*, which enforces a binary distinction between observer and observed, between subject and object. When a viewer looks at painting, the viewer is the active party, the painting is passive. A spectactor engages in a dance—a sequence of events in which each is the consequence of the last and precursor of the next. This scenario, I realized, disrupted the conventional conception of the work–viewer relationship, at least in the plastic arts.

My commitment, as an artist, to the primacy of sensorial experience led me to reject the general idea that in order to interact with a computer, one had to pre-process one’s human qualities into streams of symbolic input (keystrokes, etc.). Keyboards, pointers and screens were anathema—I objected to framing my work in the context of the business desktop environment. My systems operated in the bodily space of the spectactor, not in “virtual space.” (Through the 1990s, the incoherent trope of the “virtual” was a centrepiece of media arts and theory discourse ([Penny 2011](#b-9781474207935-009-0000173)).) I insisted that my systems had to meaningfully interpret human bodily dynamics that other humans interpret as meaningful. There would be no spoon-feeding symbols to the computer.

In insisting on sensorial immediacy, I’d set myself a technical research agenda: developing sensor-based systems that could adequately fulfil the task. The capacity of the desktop computer of the time for external non-standard input and output was almost non-existent. The same goal led me into a deep critical analysis of the technology, its capabilities, what it excluded or made difficult. It also begged enquiry about the claims made about the technology and to what degree they were justified (its implicit philosophical commitments)—many of which were part of the larger debates around AI. My works in that period functioned on two levels: to the average visitor, they were engaging technological amusements, but to those aware of theoretical debates of the day, they were critical interventions into discourse of robotics, AI and virtual reality. This article discusses these topics, along with whether (and, if so, how) these things have changed in the intervening decades. (This article has been written in parallel with my *‘*Aesthetics, Interaction and Artificial Intelligence: Contextualizing First-Generation Media Arts’ in *The Bloomsbury Encyclopedia* *of New Media Art*, Volume 2 (edited by Paul Thomas). That article traces an autobiographical, culturally contextualized story of my practice. Here I discuss underlying theoretical issues in a more academic register. I encourage readers to read both.)

## Artificial Intelligence and Biological Intelligence

I understand the term “artificial intelligence” as a disingenuous marketing strategy. A more honest name for the field might be *automated reasoning*, and if this had been the case, much of the public consternation, and much of the sensational press, would never have occurred (and much of the research funding might not have been forthcoming). First-generation *artificial intelligence* was predicated on a long tradition of humanist/rationalist thought, specifically the idea that intelligence is a matter of manipulating and communicating symbols. Words and numbers are, in this assessment, (the) vehicles in which intelligence rides. From poetry to statistics, intelligence is purported, under this interpretation, to be *representational*: it comprises the assembling and manipulation of symbols that say something about the world, about experience. AI is thus a product of a long philosophical tradition of reasoning on representations, of (logical) operations on symbols.

The philosophical tradition in which AI is grounded—Enlightenment rationalism more or less—privileges conscious logical operations, propositional knowledge. With respect to the range of ways that animals succeed in the world, this seems a very narrow conception. When a frog snaps its tongue at (what it takes to be) a fly, its brain functions as little but a fast-switching reflex action co-ordinator. A representationalist conception of cognition would argue that “phenomena as sensed” entail mental representation like “there is a fly, due south, 15 degrees elevation, travelling west at some angular speed.” When a coyote stalks a rabbit, what is it thinking about? Any “planning” is of the order of staying hidden from the rabbit while moving as close as possible. When (if) it makes the kill, is it planning how to tear apart the animal? Is its experience of the death bite and the taste of blood a computation? When a person identifies and enjoys the scent of narcissus in the late winter garden, is intelligence occurring? When we are afraid of the sound of thunder or cautious of swimming in rough surf, are we to call this “intelligence”?

The question of the relationship between artificial intelligence and the arts begs questions like those raised above because the arts are about experiences, and AI has never been about experiences. The idea that (an) AI might be capable of having something we might fairly call an experience is currently technically impossible, and not conceivable with any technology based on current techniques. Practices like my own function as a crucible—an experimental environment—for exploring such issues. Another way of understanding this question is to see it as capturing the differing viewpoints of Anglo-American analytical philosophy and “continental” phenomenological philosophy, or between the internalist, mentalist, cognitivist, computationalist cognitive science of the latter part of the twentieth century and the “postcognitivist” approaches captured by the descriptors *embodied*, *embedded*, *enactive*, *situated* and *distributed* (along with “ecological” psychology, material engagement, intersubjectivity and other neologisms). Why all these neologisms? Because the paradigms of internalist cognition that have shaped (English) language for three hundred years are crumbling.

Throughout the twentieth century in Western scholarship, there have been (roughly) two opposing teams that have understood “cognition” or intelligence through wildly different lenses. On one hand, the area roughly defined as “philosophy of mind,” and more generally as Enlightenment rationalist thought, has hewn to a symbolic orientation. Its more logico-mathematical branch has led to the automation of symbolic logic in/as digital computing. Such schools of thought assume an industrial production-line model of cognition, where thinking machinery grinds along, occasionally receiving “input” and processing it into “output” (sometimes in “packets”!). This conception of cognition implies several assumptions: that thinking occurs in a “black box” isolated from the world; that cognition is sequential; that perception occurs as a preliminary (and peripheral) input stage; that perception entails the pre-processing of sensation into symbolic tokens, which are the medium of cognition. All of these assumptions are dubious. They deploy metaphors from pre-existing technological formations, as if such models had explanatory relevance to the neurochemical soup of flows and the complex interactions that characterize biological existence.

On the other hand, thinkers whose work has been based in observations of nature, from Jakob von Uexküll, to J. J. Gibson to Humberto Maturana and Francisco Varela, have understood intelligence as what animals do to succeed in the world. This orientation has two major aspects. To paraphrase Maturana and Varela, living is cognizing, and anything that lives cognizes—down to lowly bacteria. This point of view defuses the human-exceptionalism of the Enlightenment tradition, as well as the separation of thinking from physicality, as defined in Cartesian dualism (see below). Philosophers such as Gilbert Ryle and Michael Polanyi, Martin Heidegger and Maurice Merleau-Ponty held that thinking is immersed in, is engaged with and is about *the world*—the dynamic, processual, enactive experience of living. As Gilbert Ryle put it, “Overt intelligent performances are not clues to the workings of minds; they are those workings” ([Ryle 1949](#b-9781474207935-009-0000212): 46). This allows that catching a pretty scent or avoiding danger are kinds of thinking. One might fairly object that throwing the cognitive net so wide means that nothing is left outside cognition, which for some would render the concept of marginal value. Leaving nothing “outside cognition” might serve salutary purposes outlined above, and remind us that the word “cognition” itself is defined within an Enlightenment rationalist framework.

Which brings us back to art. Art is experiential ([Dewey 1934](#b-9781474207935-009-0000114)). Very little is more basic to the rhetoric of the arts, at least in the modern period. Whether punk rock or Shakespeare, *being there* is deemed to be crucially important. Likewise, we want to see a painting “in the flesh,” that’s why we have museums. Cinema provides a problematic middle case—even if you go to the movie theatre, what you’re looking at is of the order of representation. The same can be said for recorded music—this doesn’t seem to stop us from liking it. So, from this perspective, doing art with artificial intelligence—trying to harness one to the other, or attempting to splice the two together—brings down upon our heads this implicit schism in Western culture, between what we experience and what we say about it, between what *is* and how it is described, between ontology and epistemology, between *know-how* and *know-that* ([Ryle 1949](#b-9781474207935-009-0000212)).

That is not to say that art—the arts—does not often entail a substantial amount of “saying about”—symbolic content. We, and the arts, are immersed in a Western culture in which symbolic representation is central, after all. And when we experience art, we seem compelled to talk about it, with our students or friends—that is, we construct (linguistic) representations that we purport to have some relevance to our experience, and by which we attempt to inculcate, in our listener or audience, an experience analogous to our own (which we—implicitly or explicitly—are probably recommending as a better or more authoritative kind of experience).

Deploying computational technologies and techniques in the pursuit of art making is therefore by no means a trivial *deployment* of technology. It is not simplistic tool use, like using a hammer to drive a nail. Digital computing is the epitome of a particular philosophical tradition, one to which arts practices are in some ways deeply opposed. As Theodore Roszak presciently observed: ‘Embodied in the machine there is an idea of what the mind is and how it works. The idea is there because scientists who purport to understand cognition and intelligence put it there. No other teaching tool has ever brought intellectual baggage of so consequential a kind to it’ ([Roszak 1986](#b-9781474207935-009-0000199)).

While marketers would have us believe that these technologies are simple and straightforward in their functions, this is clearly not so. The very rhetoric of enhancing productivity and efficiency that informs so much marketing blather gives lie to this. And when juxtaposed with concepts of creativity, pleasure-expanded opportunities for fun, play, sociality, even *liberation—*the armatures of a late capitalism become exposed as baldly as rocks at low tide. There is much to be deconstructed, and there is much to be constructed, if computing is to work effectively in the context of creative culture without being a *Trojan horse*, covertly importing uninvited values. Or perhaps, in these pandemic days, the appropriate metaphor is one of infection, and the diverse, debilitating (and unexpected) long-term effects.

## The Question of Artificial Intelligence

The perspective of *liveliness* provides a particular purchase on the question of artificial intelligence, because it insists on sensorimotor experience of something that gives the impression of, if not intelligence, then awareness. “It knows I’m here” is a more visceral, more *creaturely* sense of intelligence than that defined by the automation of propositional logic, abstract reasoning. The conception of reason as a matter of abstract rules was fundamental to symbolic AI, as the mechanization of symbolic logic. The perspective of *liveliness* provides a particular purchase on the question of artificial intelligence, because it insists on sensorimotor experience of something that gives the impression of, if not intelligence, then awareness. “It knows I’m here” is a more visceral, more *creaturely* sense of intelligence than that defined by the automation of propositional logic, abstract reasoning. The conception of reason as a matter of abstract rules was fundamental to symbolic AI, as the mechanization of symbolic logic. The paradigm of symbolic AI collapsed in the late 1980s as a result of the “common-sense problem,” the framing problem or the symbol-grounding problem (Harnad) and related philosophical challenges, such as John Searle’s Chinese Room, and Hubert Dreyfus’ phenomenological critique ([[1972](#b-9781474207935-009-0000117)] 1992). While Hubert Dreyfus ([[1972](#b-9781474207935-009-0000117)] 1992) was applying phenomenology to dismantle the presumptions of AI—especially the idea that “common sense” would be amenable to propositional logic—I was trying to provide my systems with a modicum of “common sense.” This was consistent with the notion of situated bottom-up robotics as proposed by Rodney Brooks and others in the artificial life movement of the 1990s. Brooks was an originator of reactive robotics and its theoretical validation. In asserting “the world is its own best model” Brooks disputed the preoccupation with mapping, planning and representation that was central to AI-based robotics ([Brooks 1991](#b-9781474207935-009-0000109)).

The challenges faced by robotics and AI in those days (the late 1980s and early 1990s) were not only due to the shortcomings of computational logic vis-à-vis common-sense: the assumption in the AI community was that common-sense *could* be represented symbolically—it was just a matter of developing the right techniques. But increasingly it came to be understood that common sense was a problem-in-principle for algorithmic computing—computers would never “get it.” That common sense was the kind of thing that *could be* represented was a fallacy. The AI community had clearly not comprehended Polanyi’s arguments about “tacit” knowledge ([Polanyi 1966](#b-9781474207935-009-0000185)). But further, the very idea that embodied experiences could be usefully “abstracted” was brought into question by Varela, Thompson and Rosch, when they noted, in 1991 (in what amounts to a postscript on the common-sense crisis):

if we wish to recover commonsense, then we must invert the representationalist attitude by treating context-dependent know-how not as a residual artefact that can be progressively eliminated by the discovery of more sophisticated rules but as, in fact, the very essence of creative cognition.

— ([Varela, Thompson and Rosch 1991](#b-9781474207935-009-0000229): 148)

Here the authors succinctly capture unjustified assumptions of Enlightenment/Platonist thought and of computationalist “functionalism” ([Putnam 1960](#b-9781474207935-009-0000188)): that embodied physical experiences are little but pointers to abstract truths in the realm of ideals. This entails three separate ideas—that abstractions reside in some immaterial “heaven” of concepts and symbols; that symbolic operations occur in the brain; and that operations upon symbolic representations in computer code are equivalent to, and interchangeable with, operations in the brain. The latter two are structured according to the assumption of that (ancient) first, revealing the dualisms that structure Western thought: that embodied experience is illusory, fallible or simply a pointer to some abstract truth. Contrarily, embodied experience is the ground of awareness and therefore cognition.

In the *internalist paradigm*, cognition happens *in the brain*, as reasoning on symbols. The idea that cognition might occur as dynamic interaction of an agent fully immersed in a world is simply unthinkable. Connecting computer to world had secondary importance: “machine perception” research was undervalued and lagged behind research into the manipulation of symbols. In the AI community it was acceptable to simply “make up” or simulate the assumed symbolic output of those imagined sensors, because the purported interpretation of sensory experience was going to amount to some kind of simple translation, a lookup table, when it finally occurred. Ha! They could not have been more wrong. The very idea that sensing is just a more or less interchangeable “peripheral,” like a headlight on a bicycle, turns out to be entirely incorrect, as they might have realized had they read Lettvin, Maturana, McCulloch and Pitts’ famous paper ‘What the Frog’s Eye Tells the Frog’s Brain’ ([Lettvin et al. 1940](#b-9781474207935-009-0000149)). The frog’s eye does not provide image data for the frog’s brain so that said brain can construct an image, infer the presence and position of a fly, then calculate tongue trajectory and instruct tongue muscles. Why? Because by then, the fly would be long gone and this particular frog would starve, thereby winning the Darwin Award for frogs by taking its genes out of the evolutionary pool.

Having no sensors to provide knowledge of the world, AI was not “situated” in any real way. The world an AI program “knew” was the world that had been described (proscribed) to it by its programmers, in databases, *representations*, symbols in code. AI was never any*where*, it was a make-believe world: imagine there is a place like this, where events of kind X are contingent on events of kind Y—now, make the right decisions. When seen in this way, the whole exercise seems absurd, or, at the very best, an abstract logical game, like chess. It should be noted that this is still largely the case. Modern machine learning draws upon symbolic content put there (in the vast databases of Google, Facebook, Amazon, etc.) *by people*, who duteously disambiguate graphics, identify faces, traffic lights, locations on maps and so on. Contemporary AI works better because the databases of human “world interpretation” are so much larger (see below).

In the Western tradition, the study of mind is embedded in a humanist tradition (rooted in Cartesianism) that has enforced both a fictitious res cogitans/res extensa dualism and equally dubious human-exceptionalism, by formulating, essentially, that intelligence is reason—hence (symbolic) AI was automated reasoning. Philosophy of mind, per Cartesianism, was prohibited from accessing empirical reasoning because mind/soul was immaterial, and therefore not amenable to empiricism. This point may require some unpacking for non-philosophers. Descartes’ strategy to avoid the unpleasantness of the inquisition (a very reasonable fear at the time) was that the person would be subdivided into two non-intersecting parts, the *res extensa* and the *res cogitans*, the material part and the thinking part. Science, and thus empiricism, would apply to all things material, and hence not to things pertaining to the immaterial soul. Philosophy of mind was thus prohibited from accessing results of measurement and experiment, due to the res cogitans/res extensa binary that rendered what we now call cognition as immaterial, and therefore in the territory of religious faith that resides beyond the reach of empiricism, which related only to material things. The (risible) result was that philosophy of mind, as a discipline, was forced to remain secluded in a medieval scholasticism, while science flourished all around it.

It is doubly ironic then that (symbolic) AI, in parallel with its rejection of cybernetics, threw its philosophical lot in with the already retrogressive Cartesian attitude, and took Putnam’s *functionalism* to defend the idea that intelligence was immaterial, and might just as easily occur in digital electronics as in neurons ([Putnam 1960](#b-9781474207935-009-0000188)). Ethology, on the other hand, concerned with the kinds of awareness of other-than-human species, was free of the constraints of both human-exceptionalism and the mind/body dualism, thus free to deploy empirical techniques. In the early years of the twentieth century, pioneer ethologist Jakob von Uexküll developed his concept of the Umwelt: the subjective experience-world that a creature is given by the kinds of senses it has ([von Uexküll 1957](#b-9781474207935-009-0000232)). The upshot being that creatures can share the same physical space but have entirely different “worlds.” This perspective provided me with ways of thinking the interactive quasi-animals I made, which made their way in their worlds by virtue of their own awareness: I developed infrared video sensing and used other sensing modalities (ultrasonic, pyroelectric, etc.) that humans do not possess.

Creatures, human and non-human, live in contingent enactive temporal flows, immersed in (always changing) contexts, always adapting. Many creatures, certainly higher animals, appear to possess this ineffable quality of *awareness*, which has no equivalent in any technology. As philosopher John Haugeland pithily noted (in an interview in Tao Ruspoli’s film *Being in the World*, 2010), the trouble with artificial intelligence is that computers don’t give a damn, which neatly demolishes that kind of apocalyptic AI dread—his point being that the kind of intelligence we have is predicated on a sense of selfhood, and we have little conception of how to put such a quality into a machine, or even if that could be possible. (This does beg the question of how it is we, as sentient beings, come to have the assurance that we are in fact “here.” It was such questions that drew me, increasingly, into consideration of matters of cognition.)

That is not to say that there are not very justified concerns regarding deployment of increasingly sophisticated AI systems—it’s just that this is not one of them. We have seen “AI-based” face recognition destined for automated surveillance systems that cannot see dark-skinned faces. There are armed drones that have the capability of autonomously identifying and pursuing targets. AI-based systems (the term is already an oversimplification) produce persuasive images, texts, videos and simulations of the voices of specific people. This trend will continue. These systems make increasingly good emulations of skilled human practices. Some exceed human ability, as chess and Go programs already have done. But none of this implies awareness or selfhood. Such concerns seem increasingly quaint.

## Cognition and Embodiment

The critique of AI as abstracted and ungrounded has special significance for me due to my training in the arts. The sensorial immediacy of art endorses a different, if seldom well-articulated, conception of intelligence. In this context, intelligence is not the manipulation of abstract symbols in some non-physical nowhere. In the doing of skilled bodily practices as an artist or artisan, it seems self-evident that cognition abides at the intersection between self and world, and not in some immaterial reasoning space. Relevantly contextualized (situated) sensorimotor behaviour is what matters in both the making of, and the experiencing of, art. This sense of intelligence is consistent with an ethological, non-human-exceptionalist biological viewpoint: intelligence is that which assures survival. This logic made von Uexküll’s work immediately relevant to me, and likewise made much of the work in A-Life (artificial life) similarly relevant. (Artificial life was the now almost forgotten flourishing of biologically inspired computing research that arose in the 1990s as a result of the collapse of first-generation symbolic AI, due the aforementioned common-sense problem—see below.)

The phenomenologically informed critique of AI had another, related, effect in the field of cognition, because the Dreyfusian argument hinged on the idea that reasoning on symbols just isn’t the way people think, and, indeed, there are diverse aspects of human being-in-the-world that cannot be easily shoehorned into a conventional dualistic conception of thinking. As J. J. Gibson put it: “What a thing is and what it means are not separate, the former being physical and the latter mental, as we are accustomed to believe” ([Gibson 1982](#b-9781474207935-009-0000120): 407). This line of thinking opens up a critique about the assumptions AI made about the nature of human cognition—assumptions that, unsurprisingly, were based in Enlightenment rationalism and philosophy of mind.

*The Embodied Mind*, by [Varela, Thompson and Rosch (1991)](#b-9781474207935-009-0000229), was an early critique of internalist, mentalist, computationalist conceptions of human cognition. This critique arose during the late 1980s, when the common-sense crisis and related critiques, such as John Searle’s Chinese Room thought experiment ([Searle 1980](#b-9781474207935-009-0000215)) and Stevan Harnad’s Symbol Grounding Problem ([Harnad 1990](#b-9781474207935-009-0000129)), brought the entire symbolic AI program into question and led some to consider alternative approaches loosely grouped around the concept of artificial life. These critiques resonated with my home-baked ideas, and I was thus drawn into critical discourses in cognitive science, and discovered a growing range of approaches called enactive, embedded, extended, situated and distributed. I was introduced to Gibson’s ecological psychology and to Maturana and Varela’s autopoietic biology, from which sprang enactive cognition. This work not only reinforced my distrust of the assumptions underlying AI and computational discourses, but provided leverage for a substantive critique of HCI (human–computer interaction). Perhaps most importantly, it provided me with a new vocabulary for thinking about the intelligences of the arts that did not demand an assumed division of mind from body. For nearly a century, artists enquiring into the cognitive dimensions of their practice, if they were philosophically or scientifically inclined, had only the language of internalism—unless they were lucky enough to discover Ryle or Polanyi. Understanding embodied practices through the lens of internalism results in exhausting mental gymnastics. The paradigms of embodied, enactive, distributed and situated cognition provide a more parsimonious way of thinking about skilled practices qua cognition.

## A-Life and A-Life Art

Through the 1990s, I was informed and encouraged by an interdisciplinary field that for a while was topical in techno-cultural circles but is now all but forgotten, except among a rarefied group of enthusiasts—artificial life or A-Life. As noted, artificial life sprang up as an alternative to the seemingly failed project of symbolic AI. Symbolic AI had set out to establish that something like human intelligence could be realized in computer programs. But the idea that “intelligence” might be achieved by the automation of symbolic logic belied a commitment to a faulty and interrogated Cartesianism. It ignored the embodied, enactive and phenomenological dimensions of human being, and rejected deployment of biological models that had been stock-in-trade for cybernetics, in which context neural networks were first developed ([McCulloch and Pitts 1943](#b-9781474207935-009-0000163)). In retrospect, it is little wonder that Good Old-Fashioned AI ([Haugeland 1985](#b-9781474207935-009-0000134)) was found to be incompetent when confronted with real life (the “common-sense” problem).

As symbolic AI collapsed, many researchers turned to biological models that AI had staunchly rejected, and in the process reconsidered much work that had occurred under the banner of cybernetics (a field that was taboo in the AI community)—the return of the repressed. Neural networks, redubbed connectionism, gained renewed interest—this work directly gave rise to contemporary machine learning (see below). Fractal geometry, complexity theory, dynamical systems theory, chaos theory and concepts of bottom-up or emergent order informed the movement, along with an examination of the “intelligences” of biological systems, particularly those of the social insects. Rodney Brooks sarcastically observed the hubris of AI, suggesting that AI should stand for “artificial insects,” for how could one presume to make synthetic human intelligence when we could not make an artificial insect?

## The “New AI”: Old Wine in New Bottles?

It is a historical irony that contemporary AI is based in technologies first-generation AI rejected. The crisis of symbolic AI (GOFAI) passed in two ways, both ironic. Firstly, contemporary AI finds its roots in neural nets—which symbolic AI rejected as biomorphic—rediscovered or resuscitated in the period of artificial life. The kind of AI that is currently regarded as most productive utilizes a technique called Multilayer Perceptrons (MLP). This in turn builds on *representation learning*, *machine learning* and *logistic regression*. Such work has roots in early cybernetics, specifically the neural networks of [McCulloch and Pitts (1943)](#b-9781474207935-009-0000163), through the work of [Hebb (1949)](#b-9781474207935-009-0000143) to [Rosenblatt (1958)](#b-9781474207935-009-0000194) and the short-lived period of parallel computing called connectionism (Rumelhart’s back-propagation ([Rumelhart, Hinton and Williams 1986](#b-9781474207935-009-0000202)) and the massively parallel, flat (as opposed to hierarchical) hardware architecture of the Connection Machine ([Hillis 1989](#b-9781474207935-009-0000146)).

There are, then, ways in which the new AI is diametrically opposed to GOFAI, and there are ways in which it is similar. The new AI is not post-symbolic: it still resides in the milieu of the representational. Its data resources, as noted, are derived largely from human crowdsourcing, though a certain amount are derived directly via sensors, surveillance systems and the Internet of Things (IoT). Contemporary AI is, essentially, statistical inference on vast amounts of collected data. One way to characterize the difference between GOFAI and contemporary AI is that in the old days (1980s) researchers deployed sophisticated algorithms on very limited datasets, while today, vast amounts of data are processed using comparatively trivial statistical processes, and the results are better. But again, this improvement is not so much a result of better techniques, but better hardware—vastly more storage, vastly more computational muscle, faster networking—the internet itself. Google, Facebook et al. provide quantities of (organized) data undreamed-of in the 1980s, when the words “terabyte,” or even “gigabyte,” were science fiction. During the heyday of symbolic AI, it was observed by iconoclastic computer engineers that all the gains of AI could be attributed to advances in processor speeds and memory capacity (Moore’s “law” (1965) states that the number of transistors on a microchip will double every two years). This argument was stifled in AI circles for understandable reasons. Goodfellow, Bengio and Courville say of contemporary AI, “Deep learning has become more useful as the amount of training data has increased*”* ([Goodfellow, Bengio and Courville 2016](#b-9781474207935-009-0000126): 11). A good argument can be made that the effectiveness of contemporary AI correlates with rapid processing of vast amounts of data. Crucially for our argument, the source of that “training” data is *people*: people identifying faces in images, correlating things in the world with maps, and making value judgements—*good burgers here*. Surveillance systems are “trained on” data disambiguated by people. People name things in the world; they make labels. From tagging photos in Facebook to reviews in Yelp, people provide the perceptual front-end for AI, turning the world into data.

I am not disputing the effectiveness of deep learning for the extraction of “knowledge” from vast databases already online. The point is that turning experience of the world into data, into symbols, demands a process that has largely been performed by humans, mostly voluntarily or unknowingly (crowdsourcing, Mechanical Turk, reCAPTCHA). AI has no more common-sense now than it did then. The new AI sidesteps the common-sense problem because the data it accesses are already symbols. Contemporary AI draws upon the knowledge of the world as understood by people (common sense)—converted by them into data then stored in vast server farms. Humans are the informational microbiome for the internet organism, converting undigestible experiences into available informational molecules. Contemporary AI is not a stand-alone technology, but a cyborgian complex with human sensory membranes like oscillating cilia feeling the world.

Goodfellow, Bengio and Courville remark, “computational units that become intelligent only via their interactions with each other is inspired by the brain” ([2016](#b-9781474207935-009-0000126): 16). This statement implies the internalist fallacy: *as if intelligence happens exclusively in the brain*. As Francisco Varela put it succinctly in 1999:

The mind cannot be separated from the entire organism … the organism as a meshwork of entirely co-determining elements makes it so that our minds are literally inseparable, not only from the external environment, but also from what Claude Bernard already called the milieu intérieur, the fact that we have not only a brain but an entire body.

— ([Varela 1999](#b-9781474207935-009-0000223): 71–89)

It appears to have escaped the notice of many cognitive scientists and most AI researchers that the brain is an organ of a body, and the two are richly cross-connected, not simply by nerves, but by endocrine, immune and neurotransmitter modalities that are still only dimly understood. For example: every red blood cell has receptors for twenty-eight neurotransmitters. This implies that so-called neurotransmitters are in fact body-wide messenger molecules (as are hormones) that do different things in different locations. This stands to reason from an evolutionary perspective—it is a general understanding of evolutionary biology that new functions occur by repurposing existing resources: as Elizabeth Bates memorably observed, *language is a new machine made of old parts* ([Bates and MacWhinney 1988](#b-9781474207935-009-0000095)). As those new activities accord advantages, they are selected for.

A key assumption of (neo-)Cartesianism is—to put it colloquially—that the brain grew a body to play with. The opposite is true: the body grew a brain. Neural tissue (in jellyfish) co-ordinates locomotion. In sea urchins it regulates the movement of the gut, of digestion. Much later it co-ordinates sensory capacities like vision, hearing and vibroception. Neural tissue exists to help an animal get along in the world. Elementary pattern recognition in light-sensitive tissue, such as shadow detection in molluscs (described by von Uexküll), implies the presence of a mobile predator between it and the sun. It is a large but plausible jump, evolutionarily, to the frog, and the link between its eye (light-sensitive neural tissue) and the activation of its tongue ([Lettvin et al. 1940](#b-9781474207935-009-0000149)). Only in the eleventh hour, evolutionarily speaking, does language occur.

## Things or Processes?

There is a nounishness to the AI approach, which is usually characterized in terms of logical *processes* operating on data *objects*. There is a comfort in the (presumed) stability of objects. Contrarily, an understanding of the processual dynamism of things was central to cybernetics, and it is a major force in postcognitivist theories of cognition. Importantly, enactivism (the theory of cognition that developed out of Maturana and Varela’s autopoietic biology) was informed along the way by phenomenology and aspects of Buddhist philosophy that focus upon embodied experiential engagement: processes of arising and passing away, of growth and decay.

Once one sets out on the path of representationalism—the idea that symbols adequately stand in for things—not only is dualism explicit, but it is assumed that representations are *sufficient*. This was the fallacy that Borges illustrated in his (very) short 1946 story “On Exactitude in Science,” in which a nation obsessed with cartography created a 1:1 scale map ([Borges [1946] 1998](#b-9781474207935-009-0000103)). A map is a representation, and any representation is a reduction, a simplification. It captures features that are deemed to be salient and leaves others out. A map cannot be a representation and simultaneously contain all the information in the source phenomenon of which it is a model. X may mark the spot, but the details of the specific nature of that spot, the kind of soil, the varieties of vegetation, are lost. Nor is that X in the world—except in absurd comedy. The argument remains, as it did for critiques of GOFAI, that these representational systems have only a vague connection with the phenomenal world. I can think of no such system that operates on phenomena themselves—as opposed to the representation of such.

## Representation and the Relationship of the Biological to the World

The question of representationalism turns on whether intelligence works on descriptions (symbols or representations) of things, or whether (biological) intelligence has access to the thing itself, the phenomenon—like the scent of narcissus. It seems absurd to say “I am smelling a representation of the scent of narcissus.” It was the case in symbolic AI (GOFAI) and it is still the case in the neural network derived contemporary practices (which, it must be remembered, were violently opposed by symbolic AI partisans Minsky and Papert). To take a Foucauldian perspective: while opposed, these two approaches are both undergirded by a common commitment to the idea of *representation*. And why not? The notion of representation is fundamental to mathematics, to logic and to humanistic scholarship in general. Indeed, the work of the academy, across the board, is (largely) work with and upon symbols. Events in the changing world are fossilized as (textual) records. Experiential irregularities are “chased” out as texts are wrought (note here the metaphorization of embodied experience: “chasing” is a technique in metalsmithing, in which a punch, repeatedly hit with a hammer, moves, shapes or flattens ridges in sheet metal). Contrarily, the clinical diagnostician in the hospital, the chemist at the lab bench, the trumpeter or the sculptor pouring molten metal: they experience a performative reality of the *dance of agency* ([Pickering 1995](#b-9781474207935-009-0000182)) with creatures and artefacts in the material world.

McCulloch and Pitts et al. stayed close to neurochemical and neuroelectrical phenomena—and stalwartly resisted identifying these as symbols or representations. Theirs was the language of analogue electronics, a language of dynamical, resonant phenomena in the temporal domain: there were “*signals*” at best. (The question of when a “signal” becomes a “symbol” takes us into deep epistemological water, hence the debate about whether Brook’s *subsumption architecture* contained representations.) Computer scientists, trained in symbolic traditions of mathematics and mathematical engineering, were not usually so careful, or even aware of the philosophical morass they were (always) already enmired in. For them, the building blocks of intelligence were the building blocks of “reason”—symbols operated upon by logical procedures. Hence the rhetorical back-formation inherent in the idea that brains use algorithms. Such an idea, if not nonsense, demands careful articulation with respect to specific cases with clear recognition that such explanations are just explanations, and are external to the throbbing, pulsing jellies they refer to. The entire sub-field of computational neuroscience may be guilty of this fundamental attribution error. It may be possible to metaphorically describe the operations of neural clusters in a language of such formal reasoning procedures, but it does not prove that such operations are actually occurring “in the flesh.”

This is the kind of logical fallacy that Humberto Maturana emphatically expounded upon for most of his career. His position was developed from a combination of biological materialism and second-order cybernetics. “Everything said is said by an observer” is perhaps the most quoted of Maturana’s aphorisms, for good reason. It points to both the separation between the observer and the observed and the idea that descriptive or explanatory labels applied by the observer to help “explain” what they see are of the order of analogy only—not in or of the observed phenomenon. To take a classically autopoietic example, to ascribe to DNA the notion of information, and to ascribe to RNA the process of transcription of information, is fallacious—there is no *information* in the cell. As Francisco Varela asserted, memorably, in biological systems, for instance the molecular processes inside a cell, “information, sensu strictu (*sic*), does not exist” ([Varela 1979](#b-9781474207935-009-0000220): 78). Katherine Hayles endorsed this, saying

Autopoiesis also changes the explanation of what circulates through the system to make it work as a system. … Indeed, one could say either that information does not exist in this paradigm or that it has sunk so deeply into the system as to become indistinguishable from the organizational properties defining the system as such.

— ([Hayles 1999](#b-9781474207935-009-0000140): 11)

In terms more pertinent to AI, Maturana emphasized the role of the observer and the map/territory problem:

A mathematical formalism is a conceptual and operational system that reveals the relational coherences of the space that it defines. … But mathematical formalisms do not provide or create by themselves an understanding of the phenomena that an observer explains to him or herself through them.

— ([Maturana 2002](#b-9781474207935-009-0000158): 18)

That is to say, the math is a story a mathematician tells herself about that which is observed. The point that is here relevant to the current discussion is twofold. First, all of the categorization of data in AI (GOFAI or the contemporary flavours) is of the order of ‘things said by an observer’: representations, mathematical formalisms. Second, none of the “intelligence” that is gained about the data is intelligence about the world, because the data are always something “said by an observer.”

## Conclusion

“What business has an artist in critiquing the rhetorics of computing and artificial intelligence?” Based on the foregoing, I propose: inasmuch as art is an example of intelligence of materially engaged type, and that this kind of intelligence is inseparable from our human existence as biologically viable creatures, it is an ideal perspective from which to conduct such a critique. Cultures of the arts implicitly if not explicitly affirm conceptions of intelligence and cognition that are inherently holistic and embodied—as is all human being-in-the-world. Art practices offer, in object lessons, counterarguments to many of the notions rhetorically affirmed by computer culture and specifically AI. Attempting to realize coherent projects that combine these different cultures creates a laboratory for working through the ramifications of this cultural collision.

I hope to have shown that computing technologies are not the kind of simple tool that can be uncritically deployed. They are complex, and impose value systems that can undermine the goals of a particular project, or, generally, of art. That is not to say that one cannot effectively use such technologies in art making, nor that new and interesting things cannot be achieved. My long history of technical development and problem solving in the service of what might be called *aesthetic* goals attests to that. But without the application of a *critical technical practice* ([Agre 1997](#b-9781474207935-009-0000089)), such work is vulnerable to, at best, naïvete, and at worst a kind of ethical undermining.

My argument is that a deep engagement both with the “nuts and bolts” of the technology, and the ideas that inform it, can lead to a more complex kind of practice that does not simply deploy pre-made tools, but originates tools and interrogates the value systems inherent in them. This may produce kinds of practices that some may struggle to identify as art, because they do not fit neatly into pre-existing and institutionalized genres. Most first-generation “new media art” existed in such a space. It may be that such work is never recuperated as “art” and into the annals of “art history”—so be it: I coined the term *Free Range Intellectual* to describe such pluridisciplinary practices, to which a friend wittily rejoindered “It’s what’s for dinner.” Such practices play in a larger field. A preoccupation with whether a thing is “art,” or worse, with a desire to pursue something identified by others as a career as an artist, seems to me, trivial and beside the point.

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Computer animation was at the forefront of digital art until the rise of multimedia and the internet during the mid-1990s. There was something attention grabbing about the unusual quality of its imagery, its mercurial transformations, intensely real and imaginary at the same time, that made it seem like a break with existing moving images. Animated film could be easily taken up by existing media channels such as television, feeding a popular interest in the application of computers to areas previously regarded as exclusively human. However, once interactivity and network-based art took centre stage, it appeared to many that these were more fundamentally new forms of media. By 2002, in his introduction to ZKM’s huge “Future Cinema” exhibition, Jeffrey Shaw wrote of digital cinema that “This domain is above all distinguished by its broad range of new interaction methodologies” ([Shaw 2003](#b-9781474207935-010-0000145): 19). In this article we take a different approach, concentrating on forms of the computer-animated image regardless of platforms that may appear as old media to some. We find that artistic innovation has continued and that a variety of imaging technologies, modes of digital production and software-based artistic practices have impacted many levels of visuality, aesthetics and language. Although this article will occasionally refer to interactive art and media systems, its focus will be on computer animation as an audio-visual form of expression. This will also give us a context in which to look at the relations between older forms of media art and so-called new media art.

## Between Art and Media

Although many definitions of animation start from a technical basis, we will begin by considering it as an overall artistic sensibility or thematics. Puppets are probably thousands of years old, mechanical automata at least a few hundred and optical toys pre-date cinema by half a century. Media researchers such as Siegfried Zielinski have done painstaking work in uncovering examples of these, but what connects them as forms of animation? Zielinski uses what he calls a “semantic field”: a set of thematically related terms that map out what animation might be—“breath”, “life”, “move”, “spirit”, “power”, “reacting”, “thinking” ([Zielinski 2013](#b-9781474207935-010-0000198): 26). This allows him to take animation into the sciences, including the electrical stimulation of cadavers, modern robotics and artificial life. Overall, these themes cohere around images of life and autonomous action. This brings to mind the popular characterization of animation as “the illusion of life”, most closely associated with the Disney Studios and their influential style of “personality animation” ([Thomas and Johnston [1981] 1995](#b-9781474207935-010-0000165)).

To create life, even its illusion, is greatly ambitious and in itself misrepresents the art of animation. Sergei Eisenstein was one of the first to write seriously about the animated film and in 1941 noted that a sufficient condition was the sensory perception of autonomous movement—“if it moves it’s alive”. He realized that the cartoon was captivating because this perception of life-like movement, unlike live-action recordings, contradicted its obviously fabricated origins. “We know that they are … drawings, and not living beings. We know that they are projections of drawings on a screen … But at the same time: We sense them as alive” ([Eisenstein [1941] 1986](#b-9781474207935-010-0000107): 54). This tension in the animated image is the key to its poetics. Michael O’Pray wrote that “This emphasis on the means of representation as being part of the representation itself seems central to much animation and lends it an uncanny air at times” ([1997](#b-9781474207935-010-0000136): 436). Esther Leslie considered this to be “The question of animation: how does a concocted substance or thing that is apparently inert begin to move, become restless?” ([2013](#b-9781474207935-010-0000113): 76).

This fabricated quality has frequently been due to the fact that animators have relied upon a patchwork of older methods of image making. In an article entitled “Animation = A Multiplication of Artforms?”, curator and critic Edwin Carels proposed that “animation is the art of the interval”, that interval being between art practices, materials and content, film frames or even metaphorically between mental states ([Carels 2006](#b-9781474207935-010-0000087)). From flipbooks to VR, animation history has always been non-linear, combining ancient art forms with the latest media technologies. Esther Leslie asks “Can we tell for sure when any one animation was made? Can one date a single animation by its technique, its ideas, its structure, the quality of its colouration or film stock?” ([2014](#b-9781474207935-010-0000119): 25). During the first decades of the twentieth century, animated film industrialized previously existing art forms for media production, both for commercial mass media and for artists’ works. Drawing was reconfigured for cartooning, built from shapes that could be most rapidly sketched, such as circles. Painting was used for long, scrolling backgrounds and sculpting for stop motion with armatures that could be repositioned. This demanded something akin to engineering as well as craft skills and visual imagination. Just as animation worked in-between older art forms and industrialized media production in the twentieth century, computer animation now works in-between earlier audio-visual media, including animated film, and post-industrial, new media production.

The Japanese media artist Toshio Iwai created his *Time Stratum* series from 1985—a nineteenth-century zoetrope updated as though the cine camera had never been invented. One hundred and twenty paper figures were arranged in a spinning dome, their positions calculated by computer and illuminated by the strobing light of a computer animation in order to more precisely control a dazzling array of cycling movements.

## Cinema

The poly-temporality of animation has contributed to the impression that it has always been lurking behind other media, pulling its strings. In 2001, Lev Manovich, a former computer animator himself, published a book that contained one of the most frequently quoted passages about digital cinema, proposing that it had revealed the true relationship between animation and live action: “[Cinema] is no longer an indexical media technology but, rather, a sub-genre of painting” and “Live-action footage is now only raw material to be manipulated by hand … Manual construction and animation of images gave birth to cinema and slipped into the margins … only to reappear as the foundation of digital cinema” ([Manovich 2001](#b-9781474207935-010-0000127): 295, 302). This thesis sometimes entered popular discourse in the oversimplified form of “all film is now animation”, implying that photographic film was now just a convenient way to create mimetic signs—the easiest way to make an image of a smiling face is to film someone actually smiling. This much emphasis could make live-action cinema seem more dependent on indexicality than it actually is (consider the history of avant-garde film, which is not necessarily mimetic nor premised on the recording of events and performances) and at other times obscure the persisting influence of lens-based media (such as the connections between the dominant grammar of film and the practice of camerawork). The reduction of film to computer animation also ran the risk of being (mis)interpreted in a solipsistic way, as though synthetic images were no longer able to come from an outside, ignoring epistemological and ethical questions. Instead, the indexical legacy of cinema has continued to mutate into new forms and functions.

Some indexes can point to an image’s internal, causative processes rather than to external objects, which is something that can apply to animation. Len Lye’s *Free Radicals* of 1958 is an abstract film to music made by scratching directly into the celluloid. Its urgent incisions are signs of Lye’s efforts to feel the music through his body, transmitting it directly onto the film like a seismograph. Despite algorithmic image generation being in principle more defined and ascertainable than ever before, it is rare that one can detect these processes in the final image as signs. In Manfred Mohr’s early computer animation *Cubic Limit* of 1974, a cube was mathematically replicated and transformed using operations that were almost simple enough to be perceivable but producing intense fluctuations between two-dimensional pattern and three-dimensional structure: “Unable to detect the complete system, the viewer nevertheless notices a strong visual force holding everything together” ([Mohr 2002](#b-9781474207935-010-0000130)). Even a film like *Cubic Limit* cannot point to its algorithm and even if it could it would not link the viewer to a meaningful act or event located in time and space.

Indexicality has also been the ethical basis of cinema: Did what we are looking at really happen? Is this image telling the truth? The distinction lies at the level of the pro-filmic: What was filmed? The animated film does not need to start with a pro-filmic scene in front of a camera so this distinction is no longer relevant. In the past this made the practice of documentary especially problematic for animation. But as animation theorist Paul Ward has argued, the photographic image only records a surface appearance that may not necessarily reveal anything significant about the forces underlying a complex situation. He concludes that any kind of image can make truth claims ([Ward 2008](#b-9781474207935-010-0000173)). Since the rise of digital visual effects, taking photorealism as indicative of indexicality and the pro-filmic has been placed in doubt but not so its ability to induce a sense of presence or “being there”. This has led to the rise of the “experiential” documentary, based on full 3D digital reconstructions of past or future events. Viewers can experience what it would have been like to stand in the streets of Pompeii as volcanic lava flowed into the town (even though they would have been suffocated by the fumes long before that). New questions arise—for example what was reconstructed? Hayoun Kwon’s *489 Years* (2016) is a 3D reconstruction of the demilitarized zone between North and South Korea. Based on the testimony of one of the few soldiers allowed into the area, it takes us through the threatening security perimeter and then into a landscape of such untouched natural beauty that the soldier can hardly describe it—“a paradise”. At this point the reconstruction falters, dropping below the geometrical ground plane to reveal its constructedness. What happens in the gap between data and experience?

New kinds of documentation have appeared such as data records that are readily amenable to being imaged using data visualization or information graphics. In the case of a stable and tractable object such as the growth of nuclear bomb tests (Isao Hashimoto’s *1945–1998* of 2003), we can easily accept that we are looking at concrete phenomena, but data structures, objects and relations can also constitute vast, “born digital” worlds. In 2008 the documentary filmmaker Douglas Gayeton made *Molotov Alva and His Search for the Creator*. Gayeton explored the online virtual world *Second Life,* recording his encounters with the other participants in a quest for answers to the meaning of life in a completely synthetic environment. The film was made by recording his investigations directly from the computer screen—*Second Life* thereby being represented entirely in its native form of real-time, interactive animation.

## Animation and Computer Animation

Has computer animation changed any of the most commonly held ideas about animation? The computer has the ability to store animation as models and data that exist as things independent of their presentation as images. Line drawings, even if rough and sketchy, can be efficiently stored as vectors so that motion and rendering effects can be applied and edited separately. In traditional animation, some kinds of data could be stored in written form using exposure sheets but the computer allows the storage of animation materials and qualities to become a general condition.

The classical definition of animation is based on an ontology of film—a film that is made frame by frame instead of shot by shot. This is still the definition used by the Academy Awards ([Academy of Motion Picture Arts and Sciences 2021](#b-9781474207935-010-0000070)). It gives the not inaccurate impression that animators are focused on a molecular level of construction. When we look at animators working on a computer, however, we see that the most frequent way of defining movement is keyframe by keyframe, plotting the extremes of an action and leaving the computer to automatically fill in the gaps or “inbetweens”. Traditional drawn or cel animation was often planned out this way as well, defining the actions pose by pose, but inbetweening by hand was highly skilled and more than enough to justify animation as a frame-by-frame process. Manual inbetweening required knowledge of the represented object as well as discontinuous changes such as in topology or anatomy—a character might temporarily gain or lose a limb while in motion. The simplified software techniques that have replaced assistant animators have caused this stage to recede as a focus of creative work. Peng-yi Tai gives a good account of how the automated interpolation of keyframes was a priority for early computer graphics scientists due to their perception of the computer’s function as being primarily to reduce human labour ([Tai 2013](#b-9781474207935-010-0000160)).

Digital keyframing with automated inbetweening is the most common animation method, ahead of procedural animation (algorithmically generated such as in computational simulations) and data driven animation (such as motion capture) ([Parent 2012](#b-9781474207935-010-0000142): 2). The traditional alternative to the keyframed or pose-to-pose method is the straight-ahead method. Here, the animator starts at the beginning of the sequence and draws each frame one after the other. This method can be more effective in capturing complex, choreographed action which is difficult to break down into independent poses. Because it cannot easily be subjected to the division of labour it was not used as often in larger studios except for short sequences (such as in music videos or adverts). It also cannot be automated by the computer in any major way. Although there is nothing to technically prevent the straight-ahead method being used—the animator could simply set a keyframe on every frame—in practice this rarely happens because animation software tends to be presented as a way to increase productivity. The result is that the straight-ahead method has sharply declined with a resultant impact on styles of animated movement.

Peter Foldes was a Hungarian artist who was closely involved in the research of software keyframing in the late 1960s. While at the National Film Board of Canada, Foldes began working with a computer scientist called Nestor Burtnyk. Burtnyk wanted to automate the traditional keyframing process and developed 2D animation software that could transform one digital line (or vector) drawing into another in what we would now recognize as a “morph”. In traditional inbetweening, continuity of form is achieved by making the features of one drawing correspond to the features of the next—an eye might morph into another eye rather than into an ear. In contrast, Burtnyk’s simplified system arbitrarily transformed features into each other, often creating a chaotic tangle of lines or “crash” at the midpoint. The result was, therefore, like neither the controlled inbetweening nor the complex metamorphoses of hand-drawn animation. Although this “crashing” effect was perceived as a technical limitation, Foldes was able to take advantage of it. In 1973 he made *Hunger*, a film that portrays a society of insatiable overconsumption. In some shots Foldes uses Burtnyk’s software to approximate inbetweening but its uniform dynamics makes the characters appear to smear from pose to pose, as though the world has been reduced to a greedily spreading, gelatinous substance. In other places he metamorphoses different objects into each other, the crashing effect making all objects and persons appear to be exchangeable commodities yet only at the cost of extreme visual violence. *Hunger* won a special jury prize at Cannes and was the first computer animated film to be nominated for an Academy Award.

## Compositing and Hybridity

A recurring challenge for animators has been how to materially construct such complex images of life, change or movement. Two common strategies have arisen. The first is the recombinatory tendency already mentioned, to take previously existing art forms and contents and combine and reconfigure them for animation production. In the domain of the computer this has sometimes resulted in media hybridity, due to its ability to simulate art forms and thereby combine them at a more structural level. The second, more challenging strategy is to invent a new plastic medium that is powerful enough to build everything from scratch—a protean substance or technique. In previous eras this might have been stucco or clockwork. A favourite for much of the twentieth century was the pencil. The computer provides new materials, such as the digital picture element (or pixel), the vector line and the algorithm itself. If things get very difficult, these strategies can be used together.

Norman Klein has defined animation as compositing, both spatially as in the layering of images and temporally by sequencing elements or frames (most obviously in stop motion) ([Klein 2004](#b-9781474207935-010-0000110): 223). Klein argues that compositing creates a collision between media, spaces and atmospheres, feeding into a Baroque aesthetic of constantly deferred collapse. The classic example was Disney’s *Snow White and the Seven Dwarfs* of 1937, which succeeded in creating a world out of layers of otherwise incongruous hand-drawn cartoons, painted backgrounds, humans based on live-action recordings and lip-synched dialogue. Klein argues that the poetics of animation is based on artifice—a sense of wonder at the animated world’s fragile continuity, heightened by fear of its imminent failure: “Animation is a string of instants when you sense that this could not be real” (ibid.: 249). Klein contrasts artifice based on compositing (with its emphasis on layering and fragility) with modernist montage (with its emphasis on juxtaposition and critique). By the early 1990s, cheap scanners and video grabbers made all manner of content available in one common, digitally malleable form, leading to an upsurge of recombinatory work that exhibited both artifice and critical constructions.

Peter Callas’s *Neo Geo: An American Purchase* (1989) appropriated every conceivable sign, symbol and icon in the history of American culture, compressing them into a stream of screaming visual excess. Keith Piper’s *Go West Young Man* (1996) combined archive images of the slave trade, contemporary protest and personal testimony to create a tapestry of racial history in Britain. David Blair’s *Wax, or the Discovery of Television among the Bees* (1991) was a seminal narrative feature that used live-action video, archive stills, videographic effects and 3D computer animation to tell a meta-historical tale about a man who believes that his bees are turning him into a weapon for the Gulf War. Blair described his desire to use electronic media to process the narrative as well as the image ([Blair 1996](#b-9781474207935-010-0000077): 319), resulting in a story that shifted between very different levels and modalities. In 2009, the French collective H5 made the Cannes Festival and Oscar winning short *Logorama* in which they constructed a three-dimensional metropolis out of giant company logos and brand names. After a typical Hollywood police chase goes wrong, the urban sprawl suffers an earthquake and sinks beneath the ocean. Even if Capitalism topples, its death must be a sight of awe-inspiring proportions. It is not clear if Klein believes in the possibility of a critical Baroque, but one self-reflexive example might be Jason White and Richard Wright’s *Heliocentrum* of 1995. The film reconstructs Louis XIV’s palace at Versailles as a modern pleasure dome of electronic effects and digital pyrotechnics, contending that there are historical precedents for the political use of spectacular, virtual environments.

As well as contents, the computer allowed different craft and media practices to be combined by reconstituting them in digital form. The digital simulation of cut-out animation, hand-drawn animation or three-dimensional model making has allowed numerous hybrids to appear. Digital hand-drawn animation is hybridized with cel animation by virtue of the fact that all drawing software offers the facility of layering. These digital layers will accept any kind of mark making, not just the inks and paints that adhered to acetate cels. The popular method of 3D character animation pioneered by Pixar supports the language of classical Disney animation by implementing traditional 2D pose-to-pose animation. This animation is applied to computer models and then rendered using a simulation of 3D photorealism. There are at least two different simulations mentioned here (and in reality, many more) that combine to create new methods of animation. These digitally encoded hybrids quickly become so complex that the original ways of working can fade from memory, leaving the artist struggling to grasp what it is that their artistic practice actually consists of. One answer is that we enter a media ecology in which traditional practices continue to be identifiable, intermixing yet surviving both inside and outside of the computer.

There are some animation methods that are more obviously hybrid. Traditional rotoscoping is a way of incorporating live action into animated movement by drawing over the footage (although often using it as general reference rather than for simple tracing). Originally invented by Max Fleischer in 1915, the intention was to use it to more easily (and cheaply) achieve the “natural” movement that was desired by the fluid style of character animation that was then evolving. In the late 1990s a computer programmer and filmmaker called Bob Sabiston produced a software application called Rotoshop which added layering and keyframing to optimize the method into a digital hybrid, allowing it to be used much more extensively. Theorist Paul Ward points out that instead of being shown alongside drawn cartoon animation as before, these new films are shot entirely on video and then entirely rotoscoped. Instead of the viewer seeing different styles of animated movement they now see animation and live action—a hybrid of media rather than of artistic styles ([Ward 2004](#b-9781474207935-010-0000168): 37). After successful shorts like *Snack and Drink* (2000), Sabiston made the feature-length *Waking Life* (2001) with live-action director Richard Linklater. The film portrays a character who is trying to awaken from a dream and in the process meets a variety of characters who expound their ideas on the nature of free will, identity and consciousness. Each of these scenes was rotoscoped by a different artist in their own personal style, suggesting a correspondence with the individual, subjective viewpoint of each character we meet. As in later films such as Ari Folman’s *Waltz with Bashir* (2008), we see a live-action director associating animation itself with certain levels of reality—that of dreams, memories or psychic states. More recently other approaches have emerged, such as in Keith Maitland’s *Tower* (2016), where rotoscoping was used to treat source materials so it would not be obvious that they were taken from different historical periods.

The last example hybridizes digital rotoscoping into a general interface for reinterpreting the moving image. Aaron Koblin and Chris Milk’s *The Johnny Cash Project* (2010) is a website in which the public is invited to rotoscope a single frame of the live-action music video of one of Johnny Cash’s last recordings—“Ain’t No Grave”. As it grows, each frame is filled in by a different fan, some painting over the photographic tones and outlines, others drawing symbols of crosses, skulls and angel wings, writing little epithets or adding their own self-portrait. Continuous playback produces an outpouring of these individual tributes, barely held together by the underlying video stream, while stepping through it frame by frame produces a gallery of quite separate paintings. A collective, artistic homage to the Man in Black or a document of mass subjectivity, coalesced around one iconic, celebrity artist.

## Abstraction and Synthesis

The desire to find a new visual language based on fundamental units has been a driving force behind much abstract animation. The pioneers of computer animation as art are often taken to be John and James Whitney. As early as the 1940s they were unhappy with abstract film (such as that of their friend Oskar Fischinger) because it relied on handmade marks such as painting. They began experimenting with the use of line and dot stencils, anticipating some of the core concepts of CGI such as the vector and the pixel. James Whitney made mandala-like films intended to expand personal consciousness during meditation sessions. The first version of his film *Yantra* was finished in 1955, made by sticking pins into cardboard and shining lights through them. One can find a few other early examples of this impulse in the history of animation, such as the pinscreen invented by Alexandre Alexeieff and Claire Parker in 1932.

In the 1950s John Whitney, aided by his brother, built his own analogue computer out of an anti-aircraft gun sight and used it to move artwork under a rostrum camera, thereby creating the first motion-control system. In 1966 he was invited by Jack Citron, a researcher at IBM, to use their computers as their first artist-in-residence. After this, Whitney made his most well-known films, *Permutations* in 1967 and *Arabesque* in 1975, describing his aims in terms of expressing a visual dynamic similar to the mathematical structures underlying musical language. “The scattered points fall into some ordered symmetrical figure when all the numerical values of the equation reach some integer or whole number set of ratios. The effect is to subtly generate and resolve tension—which is similar to the primary emotional power of music composition” ([Whitney 1972](#b-9781474207935-010-0000178)).

Over the following years, artists continued to explore the algorithmically generated moving image, often exploiting newly invented mathematical objects such as fractals, cellular automata and chaotic systems, or scientific concepts such as evolution. By the early 1990s a style of strident, technologically existential imagery had emerged, typified by artists such as Karl Sims (*Primordial Dance*, 1991), Yoichiro Kawaguchi (*Eggy*, 1990) and William Latham (*Evolution of Form*, 1991). In some ways it hearkened back to the Neo-Constructivist’s desire to find visual languages that were radically anti-humanist (e.g. Manfred Mohr or John Stehura). An important difference was that this new work had an overwhelming level of surface detail rendered using photorealistic visual effects, giving the most abstruse data a crisp sheen, turning a 2D surface into a window onto a grand perspective. Eliciting a compulsive fascination and an increasingly affective response, it threatened to stray far from a more penetrating discourse. Some of this imagery found a home in the popular techno-culture of the period. The artist Robert Pepperell created a company called Hex Media to create Rave videos for musicians such as Coldcut yet also saw this work as part of his experimental arts practice. More recently some artists have returned to these topics, possibly with the benefit of distance. Thorsten Fleisch’s *Gestalt* (2003–8) is an animated visualization of a 3D fractal and is treated with such commitment that we sense a severe and impassive beauty.

In 1999 the multimedia authoring package Flash introduced an object-oriented programming (OOP) language called ActionScript. This made accessible a new programming approach in which micro-elements could be encoded as OOP objects with simple behaviours and then quickly replicated. OOP code was also easily sharable and a strong community of designers grew up around Flash. An aesthetic based on small, interacting components emerged, echoing the contemporary net-cultural meme of the “digital Gaia”—an ecological interpretation of the web as globally interconnected and independent agents. The foremost Flash designer of the time, Joshua Davis, commented: “our work should reflect the nature of a fern and be comprised of tiny little objects that all talk to each other. The more we add these little objects, the more complex and intense the nature of our work becomes” ([Davis 2001](#b-9781474207935-010-0000099): 515). One designer who is still active is the Austrian Walter Gorgosilits at dextro.org, generating gossamer fields of wisps, shards and dessicated textures—often decorative, sometimes phenomenal. More recently this spirit has been taken forward by artists and designers associated with open-source software communities such as openFrameworks, Processing and Cinder.

During the 2000s, new directions started to emerge. The artist Matt Hattler introduced a more eclectic approach, showing ways that abstract animation can have a wider cultural and political resonance. His *Collision* of 2005 appears at first to be using motion graphics software to create familiar radiating patterns out of tiny geometric shapes. Then the elements of the stars and stripes flag are recognized, counterpoised with the crescents and stars of Middle Eastern flags and Islamic geometrical art, shuddering and convulsing as they connect, two regimes of abstract form struggling to resolve their tensions. His *Spin* of 2010 is a Busby Berkeley-style dance video made out of CGI toy soldiers that satirizes the role of military spectacle as entertainment. We see here the potential of using CGI to hybridize abstract animation, exploiting subtle associations with signs and symbols and greatly increasing the power of its typical language.

## Realism

Classical Disney animators stressed that what they were aiming for was not realism but “believability” ([Williams 2009](#b-9781474207935-010-0000183): 370). Characters should appear to be autonomous beings that live and breathe through a coherent rhythm of forces and existing in a different, in this case caricatured, world. As has been noted before, that we “believe” in these creatures yet can easily see that they are not “real” has been central to the art of animation. What happens when the edges become blurred is one of the matters that concern us in this section.

Realistic, 3D computer graphics is something that has fascinated and repelled artists, computer scientists and the public alike. Ed Emshwiller’s *Sunstone* gave us an early glimpse, made with one of scientist Alvy Ray Smith’s first full-colour frame stores at the New York Institute of Technology’s CG Lab in 1979. Combined with texturing software by Lance Williams, it showed how far the computer might be able to simulate the appearance of any visual medium or substance. The thought that an entire synthetic world with all the multifarious visual detail of our own everyday experience could be generated by nothing more than the protean manipulation of numbers became a compelling idea for artists as well as scientists ([Wright 1996](#b-9781474207935-010-0000186)).

Computer animation can be “realistic” in a greater number of different ways, through movement or by being perfectly in focus, by being based on scientific models or by visualizing data. If part of an interactive game, it can seem realistic by being more responsive and fluid. But this situation is more complex than it appears. Andy Darley began to argue that commercial CGI was aiming not at representing the “real world” but at reproducing the various conventions of cinematic representation—a “second-order realism”. An early example is Pixar’s *Red’s Dream* of 1987, the film in which the studio first achieved their influential 3D incarnation of Disney-style animation. A sense of uncertainty about the origins of this animated image haunts the film: “One becomes fascinated with the imagery precisely because of this uncertainty, seduced by the ways it recasts, amalgamates and *confuses* familiar techniques and forms” ([Darley 2000](#b-9781474207935-010-0000096): 84). The difference with classical Disney is that here the imagery is not a result of combining techniques but a simulation of them, in digital form. It hybridizes (and exceeds) the models of classical animation, 3D puppetry and live action in the pursuit of heightened illusionism instead of reproducing their imagery. This strategy shows no signs of exhausting itself even today, as Disney’s *Feast* (2014) and *Spider-Man: Into the Spider-Verse* (2018) can testify. At this point hybridity and synthesis become part of the same project—once computer graphics has achieved the ability to build everything from scratch, it can hybridize the forms it has simulated and use photographically styled rendering to disguise the joins.

Much computer-generated realism depends on the implementation of scientific models of the physical world—ways to represent solid, liquid or gaseous objects, zoologically correct animals, how light transport makes surfaces visible. *Final Fantasy: The Spirits Within* of 2001 was an early attempt to create completely synthetic humans within a cinematic style modelled on action films of the 1980s (such as James Cameron’s *Aliens*). Film theorist Vivian Sobchack describes the film as hyperrealist, meaning that it is more realistic than the real in some ways, such as when the images are closely based on physically accurate models ([Sobchack 2006](#b-9781474207935-010-0000154)). The viewer ends up intensely scrutinizing the characters for tiny signs of irreality, such as the 60,000 strands needed to model the hero Aki Ross’s hair. This results in an image that invites the kind of interrogation appropriate to a piece of photographic evidence as much as the interpretation of a cinematic sign. There arises a conflict in the viewer as to whether they are watching indexical images for epistemological purposes or symbolic images for semiotic purposes. Computer animation becomes an exercise in judging what kind of medium you are watching.

An area of realism that more deliberately engages scientific methods is the use of data visualization, presenting artists with the challenge of using datasets for expressive purposes, just as scientists struggle with turning image making into a research methodology ([Wright 2008](#b-9781474207935-010-0000192)). Justine Cooper’s *RAPT* of 1998 is a cavernous animated journey through MRI scans of her own body. This is a new kind of self-portrait that places us at the material limits of personal distance and in doing so asks us how it affects our sense of intimacy and exposure. Marina Zurkow’s *Mesocosm* of 2011 uses data recorded from the north-east England moors to drive drawn animation cycles. The interactions in this artificial community of people, animals, plants, sun and moon are thereby controlled by an actual environment, while a lone, foreground figure watches and waits, perhaps for a change in the weather. Ryoji Ikeda’s *Supersymmetry* (2015) comes close to allegorizing the process of scientific visualization itself. This large-scale installation begins with an experiment of cascading ball bearings that appear to be detected using various scanning devices. In an adjoining room an immersive bank of monitors analyses this chaotic “quantum foam” by rapidly applying an entire vocabulary of graphical techniques, as though putting the viewer inside “Big Data” science as a panorama.

Visual effects have often struggled to be regarded as more than a technical service to live-action cinematography. Since visual effects became more accessible in the 2000s, we have seen a steady take-up by artists, resulting in many new directions. The Japanese artist Hiraki Sawa made *Dwelling* in 2002, subtly altering the domestic space of his London flat by compositing tiny airplanes, bringing the transitory space of the exile inside his temporary home. In *Avatar Days* (2010), Gavin Kelly interviewed gamers and then placed their outlandish, fantasy 3D avatars onto the dull, grey streets of their local city, offering a new perspective on their owners’ mediated subjectivities. Entertaining but also provocative kinds of fake documentaries appeared. Till Nowak’s *Centrifuge Brain Project* (2011) purports to be about a scientist who has designed impossibly extreme roller coaster rides, as utopian experiments to free the mind from gravity. The film teased viewers by showing them rides that were so thrilling that some members of the audience did not wish to disbelieve their existence.

Some artists have been exploring the affective qualities of 3D animation. One subgenre became referred to as “bad 3D”. James Lowne’s 2011 film *Our Relationships Will Become Radiant* shreds the normally bulletproof surfaces of 3D geometries, cripples characters with their own rigging and painfully stretches texture maps to instil a sense of wretchedness and unease. The “uncanny valley” is a term used to refer to the troubling appearance of characters who are nearly but not absolutely photoreal, and there are signs it could feed into an aesthetic that outlives its status as a temporary technological limitation. In contemporary artist Ed Atkins’ *Good Boy* (2017) we approach a seated boy from behind who shakes as though sobbing, then at the last moment he spins around to confront us with his tears. His shiny, synthetic features displace the emotion we expected to feel in response, instead the character appears to be agonizing over the fact that they cannot adequately simulate their own sadness.

## Production

In a 2003 addendum to his study of the Hollywood cartoon, historian Michael Barrier declared that there have been no advances in the art of cartoon animation since the 1950s, ascribing the recent success of the Pixar films to the scriptwriting ([Barrier 1999](#b-9781474207935-010-0000072): 573). Even if we accept this, we can argue that story development has itself been impacted by computerization. A typical animated feature can be produced in about a year but might be in story development for two. In his professional autobiography, Pixar’s studio head Ed Catmull describes many ways in which they have used technology to enhance pre-production—pre-visualization, collaborative storyboarding, the “Review Sketch Tool”, the “Pitch Doctor” ([Catmull 2014](#b-9781474207935-010-0000093)). The result is an unprecedented level of narrative coherence. In a Pixar film, every action and pose is super legible, every event interlocks perfectly with the next. Film theorist David Bordwell has written about the way that narrative approaches of the past have evolved into an “intensified continuity”—utilizing faster cutting, more close-ups and a more discerning use of narrative devices in general ([Bordwell 2006](#b-9781474207935-010-0000084): 147). In mainstream computer animation we can see that this intensification has permeated all levels of story.

The computer has made it possible to store and thereby separate different parts of the production—movement, models, layers, rendering. The result is that the workflow pulls in two different directions—it can break up into more specialized roles or it can make the whole process more accessible and fluid, by both encapsulating operations into one software application and by automating some tasks. Companies such as Epic have promoted their real-time games engine Unreal as “democratizing” because so much of the scene building and rendering is available as presets, “taking away the drudgery” ([Lumsden 2020](#b-9781474207935-010-0000125)). According to this logic, a writer is supposed to gain more control over their story because they can drive the whole process themselves. But this is only if they accept that they have less control over the visual language, built from library scenery, metahuman characters, motion captured actions and all rendered in its default photorealism. Some other services pursue filmmaking automation even more explicitly. Plotagon, founded in 2012, will generate a video directly from a written script, using a library of customizable characters, actions and lip-synched speech synthesis—“Write your script, press play”. In this convergence of classical film style, asset libraries and software interfacing, computer animation is no longer a form of animation but an automated form of live action.

Motion capture (mo-cap) has become a prominent animation technique which threatens to replace some creative roles. Animator turned historian Tom Sito sees its attraction to film executives as being a way to sidestep artists and generate CG performance as a dependable commodity ([Sito 2015](#b-9781474207935-010-0000151): 209). Unlike rotoscoping, digital mo-cap extracts only the 3D movement data from an actor’s performance so that their entire body can be replaced by a compatible model. James Cameron claimed that the enhanced performance capture technologies he used to make *Avatar* (2009) were so accurate that there was no diminishment of the actor’s performance whatsoever ([Discovery 2009](#b-9781474207935-010-0000105)). The question then arises as to whether there is any role left for the animator. Sito questioned animators that worked on *Avatar* and the earlier Gollum character in *Lord of the Rings* (2001) and found that on average 60–80 percent of the performance came from the motion capture sessions with the rest being animated ([Sito 2015](#b-9781474207935-010-0000151): 212). Motion capture has the potential to turn into a true collaborative art form between animators and performers. However, one may expect resistance from some Hollywood producers who anticipate a star actor’s reaction to the news that their performance might be reanimated by someone they have never met.

The release of cheap motion capture devices from around 2010 has opened up the technology to independent artists. The Butler Brothers have extensively used motion capture to enable them to make a long series of biting social and political satires such as *The Utility Curve* of 2015. In these dystopian futures, automata-like individuals are caught up in a system of on-demand labour that attempts to commodify every last scrap of human action and desire.

## Conclusion

There is another history of computer animation that starts with the earliest attempts to interact with the computer itself. In 1962, computer scientist Ivan Sutherland presented a computer–human interface (CHI) system called Sketchpad that could be used to plot and manipulate graphical objects in real time. Sutherland described it not as a drawing system but as a different conception of what a computer was—for when you don’t know what you want to do in advance and want to “sketch” out ideas. The emphasis begins to shift from instrumental problem solving to experimentation, the creative process and a more symbiotic relationship. By the end of the 1960s Sutherland had joined David Evans to form a company that made flight simulators, developing fast graphics hardware that pioneered real-time animation. This also opened the door to creating interactive graphical interfaces for software applications, spearheaded at Xerox PARC in Palo Alto, California. By the mid-1980s high-end, off-the-shelf animation applications such as Alias and Wavefront began to appear. In 1985, the UK company Quantel released Harry—their first broadcast-quality, effects editing system. Running on dedicated hardware, these systems offered a highly responsive, gestural interface which made operating one feel closer to playing a computer game.

Early computer animation required long calculation times and this lack of timely feedback made authoring, crafting and editing difficult. To make these forms of animation practice tractable, animation software itself needed to become animated. This goes to the heart of art making in general as a set of deeply embodied practices. We must come to feel that the computer’s response to our action is in fact one action, and it is this which allows for a practitioner’s development of tacit knowledge or “knowing-in-action”. “Work quickly” urges the art teacher. The rapid iterative cycles of “thinking-through-making” are the principle of the designer. The ability of the computer to attain human scales of temporality allowed rhythms of interaction and feedback to emerge—the time it takes for humans to perceive a pattern or a connection, to act, react, recall or build muscle memory must synchronize. Rhythm and timing are an important yet poorly appreciated aspect of interface design. This animation of software has proved to be generally enabling for all authored digital media. Just as in the early twentieth century the visual arts had to become animated to allow its integration into film production, in this century animation is itself reconfigured by animation software as a computer interface.

In 2001 Adrian Ward made a parody software art project called *Auto-Illustrator* which explicitly animated itself. When the user tried to use a drawing tool, they discovered that a generative algorithm had taken over, scattering their marks over the canvas, introducing random wiggles or dicing up the surface. A few years later, an approach to animated film emerged called the “diegetic desktop”. Taking advantage of the fact that much of people’s day-to-day communication takes place via the computer screen, filmmakers started to use the desktop interface as both the location for and the means by which a story was narrated. Ian Gouldstone’s *Guy 101* of 2005 tells the story of an online encounter by skilfully animating a user’s interactions with file managers, message boards and websites to manipulate point-of-view and story information. Jeremy Bailey’s *VideoPaint 2.0* of 2006 features the artist sarcastically performing the operation of a software art interface. Bailey presents us with a world in which every movement can be isolated, calibrated and tracked, resulting in a fetishization of physical expression. Now the wheel turns full circle, with artists mimicking the “movements” of computer animation software that was originally designed to replace a handcrafted practice.

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The term “new media art” covers numerous, diverse phenomena with their own specific properties. This diversity sometimes leads to attempts at defining new media art by juxtaposing its various types. However, this renders the term meaningless, yielding in essence merely a collective term while failing to provide criteria for considering these particular types as forms of new media art. A definition, therefore, should indicate what unites these types and makes them new media art, including identifying what makes new media “new.” The field of new media art remains unstable, constantly in a process of transformation. This is so not merely because of the emergence of new and different types of media, but also because of the transformations constantly taking place in the multi-directional relations between them, including those resulting from processes such as technological convergence, divergence and remediation, which shape different media configurations and produce hybrid forms. At the same time, however, this fact does not mean we are dealing with a process of substitution, that newer media merely supplant those that preceded them in time and assume their position and status, thereby becoming “newer” new media. On the contrary, newer media join older forms, thus expanding the overall field of new media and deepening its internal differentiation. This is precisely what has occurred in new media art, whose individual types, although seemingly rooted in the characteristics of the new media that gave birth to them, in fact, have acquired their own character and status in relation to the overall new media environment.

The category of *new media art* came into general use in the mid-1990s ([Tribe and Jana 2006](#b-9781474207935-011-0000285): 7). The forms of artistic activity associated with it, whose beginnings I trace back to the 1950s in the development of cybernetic and oscilloscope art, and the academic and critical studies that followed these transformations in art, have their own, even longer history. The theoretical approaches to new media art developed by scholars and critics feature relevant concepts and terminology ([Burnham 1968a](#b-9781474207935-011-0000137), b; [Reichardt 1971](#b-9781474207935-011-0000270); [Nake 1974](#b-9781474207935-011-0000249); [Druckrey 1996](#b-9781474207935-011-0000166); [Sommerer and Mignonneau 1998](#b-9781474207935-011-0000282); [Manovich 2001](#b-9781474207935-011-0000240); [Wilson 2002](#b-9781474207935-011-0000297); [Tribe and Jana 2006](#b-9781474207935-011-0000285); [Shanken 2009](#b-9781474207935-011-0000276)), proposals for a historical ordering ([Cubitt and Thomas 2013](#b-9781474207935-011-0000155); [Frieling and Daniels 2004](#b-9781474207935-011-0000181); [Grau 2003](#b-9781474207935-011-0000190), [2007](#b-9781474207935-011-0000193); [Rush 1999](#b-9781474207935-011-0000273); [Wands 2006](#b-9781474207935-011-0000288); [Youngblood 1970](#b-9781474207935-011-0000306)) and monographic studies dedicated to numerous trends in and types of new media art ([Ascott 2003](#b-9781474207935-011-0000131); [Dixon and Smith 2007](#b-9781474207935-011-0000163); [Franke 1971](#b-9781474207935-011-0000178); [Goldberg 2000](#b-9781474207935-011-0000187); [Greene 2004](#b-9781474207935-011-0000196); [Kac 2005](#b-9781474207935-011-0000208); [Kahn 1999](#b-9781474207935-011-0000211); [Menkman 2011](#b-9781474207935-011-0000246); [Paul 2003](#b-9781474207935-011-0000258); [Raley 2009](#b-9781474207935-011-0000267); [Weibel 2001](#b-9781474207935-011-0000291)). Many books on the work of selected artists and analyses of individual works have also been published. In conjunction with the development of new media art and scholarly reflection on it, a number of university courses and programmes in art colleges were established. An institutional and exhibition system also developed, supporting the production and presentation of works and the realization of artistic and research projects (such as the Ars Electronica Center, Linz; ZKM ‒ Media Art Center, Karlsruhe; InterCommunication Center, Tokyo). The major first new media art exhibitions were held (“Cybernetic Serendipity,” 1968; “Software,” 1970), and new media art magazines (such as *Leonardo*, *Neural*, *Artnodes*), internet sites (such as Rhizome; Netzspannung.org; ADA: Archive of Digital Art) and festivals (such as Ars Electronica, Linz; European Media Art Festival, Osnabrück; Multimediale, Karlsruhe or Transmediale, Berlin) emerged. New media art thereby acquired a full-fledged institutional framework.

This article analyses the concept and multi-form phenomenon of new media art on four levels. The first section considers the interaction between *art theory* together with the related conceptual understanding of medium as an artistic discipline and a material; and *media theory*, together with its approach to the medium as a technical means of communication. The next section focuses on properties that characterize new media and new media art, and the consequences of trying to define them by assigning them a set of defining characteristics. Here, I draw attention in particular to the possibilities that emerge from understanding new media and new media art without placing them on a historical timeline. The third section gives an overview of the history of new media art and examines the complexity and multiplicity of its types, revealing their diverse status. In the final section I highlight three basic factors of new media art:

* *newmediality* ‒ the “technical-new media” properties of new media art that emerged as a result of the introduction of new technical means of communication into the field of art as tools for creative work;
* *transmediality* ‒ the interaction between new and traditional media, whereby art utilizing old and new technical means enters into a meaningful relationship or is even integrated into traditional fields of art, creating transmedial forms;
* *transdisciplinarity* ‒ the relations between artistic new media and transmedia disciplines and other, non-artistic disciplines of social practice, such as science, the humanities, politics and social activism. These relationships result in the construction of transdisciplinary artistic forms.

Over time changes in the hierarchy among these three factors have shaped new media art history, a process I examine using a number of concepts found in new media art theory.

## Between Art Theory and Media Theory

If we look at how new media art has been discussed in the literature to date, we see that this concept has been shaped in relation to two distinct paradigms. In each of them the notion of medium is understood differently, and the boundary between old and new media is located in a different place.

The first is art theory. Within this paradigm, “medium” means the methods, materials and tools used in creative work and the manner in which their relation to a work is shaped. The *Oxford Illustrated Encyclopedia* defines it very precisely:

Medium, a term in art used in its broadest sense to describe the various methods and materials of the artist; thus painting, sculpture, and drawing are three different media, and bronze, marble, and wood are three of the media of sculpture. In a more restricted sense, the word refers to the substance with which pigment is mixed to make paint, for example, water in water-colour painting, egg yolk in tempera, and linseed oil in oil painting.

— ([Norwich 1990](#b-9781474207935-011-0000252): 289)

All media in this context ‒ old and new ‒ are relatively coherent sets of historically connected materials and structural determinants defining art, around which various types of art have arisen or, to state it differently, various fields of artistic creativity defined by different combinations of materials, methods and tools have come into being. Classical (old) media in art are the manual methods and physical materials traditionally used in creative work. New media in art, on the other hand, are fields in which the tools and creative work methods utilized are radically different from those used in classical media, and are generally labelled non-traditional. These material and structural innovations lead to further, even more far-reaching changes. New media differ from classical media not only in the tools and materials used and the ways in which works are produced, but also in their conception of the creative process and the position and role of the artist in it, as well as the status of the work itself (upsetting the notions of objectivity, uniqueness, materiality and durability). The properties of the resulting works, which are largely related to those of new media, are the source of the difference between traditional (old) and new media.

New media in this context include photography and film, which, unlike traditional media, make use of technical, semi-automated and autonomous tools and procedures (operating to a certain extent outside the field of the artist՚s agency), and use light as a material to bring into existence new types of artefacts. To these technical new media, we can add video and a variety of computer media, in which these differences are further accentuated.

The second paradigm in the context of which the notion of new media art is framed is media and communication theory, and, within it, theory of technical media (i.e. apparatus-based media: apparatus-based production, distribution/sharing and reception). The concept of medium is understood here as “an intermediate agency that enables communication to take place” (O՚Sullivan et al. 1995: 176). In this case, the basic definition of the medium is quite different from the one used in the context of art theory. “The medium is basically the technical or physical means of converting the message into a signal capable of being transmitted along the channel” ([Fiske 1990](#b-9781474207935-011-0000172): 17). Defined in this way, media are not in themselves related to art, but rather serve as a means for communication. They become relevant to art only when they are used as art media. Communication media were created and developed over centuries, and include speech, writing, printing, telegraph, photography, radio and television. When we accept and include in our considerations Marshall McLuhan’s concept of media as extensions (“All media are extensions of some human faculty ‒ psychic or physical”; [McLuhan and Fiore 1967](#b-9781474207935-011-0000243): 26), the spectrum of mediality expands considerably. Refashioning the concept of medium in this way—which initially seems to challenge the theory of media as communication—serves us well today, in our era of internet communication and virtual and augmented reality, and enhances the power of critical reflection on art projects organized around new media, especially those focused on new media art’s transdisciplinary factor. It also opens the way for such new media as robotics, AI, biotechnology and nanotechnology, and corresponding artistic uses.

The process of shaping new media began within this paradigm in the 1940s, with the invention of the electronic computer, and progressed dynamically over the next half-century, through the successive introduction of new media technologies, such as VR, hypermedia and mobile and locative media, up until the moment of the second birth of the internet (the World Wide Web) and the emergence of a widely shared belief that the world of media and communication practices has been completely transformed and acquired new dimensions ([Lister et al. 2009](#b-9781474207935-011-0000234): 10).

New media have fundamentally altered prevailing concepts, structures and forms tied to communication processes, transforming the relations between their participants and the forms of activity expected from them, and introducing new methods for obtaining information and shaping experience. Sweeping changes have occurred in all the most important aspects of the new media environment and, consequently, in the new fields of art that have developed around them; this includes the means of engaging participants in communication, the roles and tasks foreseen for them, and the devices created to meet these new challenges.

In distinguishing these two paradigms for considering old and new media in art, it is also worth emphasizing the differences in the meanings of two categories: the *media of art* and *media art*. The word “media” has a different meaning in each of these expressions, and, in each case, maintains a connection with one of the two previously indicated paradigms. In the media of art, the word “media” means all the means and materials used in artistic creation. Here we remain within the context of art theory. In the concept of media art, the word “media” refers to the technical media that are used as a medium of art. Here we are operating under the influence of media and communication theory. These two categories designate two groups of artistic types.

One would expect that media art simply falls within the realm of the media of art, comprising a distinct separate part of it. However, the interrelationship between the two concepts ‒ when viewed historically ‒ is more complicated. This is evident, for example, in a distinction proposed by Christiane [Paul (2003)](#b-9781474207935-011-0000258) in regard to digital technologies, which she argues can be used as either *tools* or *media*. Extending Paul՚s position to all—and not just digital—media technologies, we can say that they not only make possible both media art and new media art, but also, to varying degrees, influence all other media of art. These new technological tools not only can be used to bolster creative processes in traditional media; they can also endow the works thus created with properties that are distinct from those otherwise found in such traditional media, which in turn influences the nature of their reception. The clarity of the distinction proposed by Paul between *tools* (which serve artists in their creative work) and *media* (which create new forms of receptive, artistic experience) is slowly weakening, and sometimes even disappearing in relation to the hybridity of contemporary art. Thus, media art and new media are no longer a separate enclave or enclaves within the realm of the media of art; they permeate it throughout, yielding mixed forms, including multi-, inter- and transmedia.

In becoming instruments and an environment for artistic practices, new media technologies have not only profoundly changed the character and course of creative processes and the properties of the resulting works, as I wrote earlier. They have also fundamentally transformed the ways in which these works are perceived by viewers, thus establishing entirely new frameworks for experiencing the art created. As a result, they also completely transform the overall understanding of aesthetic experience, including its concepts, structures and key components. Consequently, some technical media that fall within the first paradigm once had the status of new media, such as photography or film, but within the second paradigm were transferred into the circle of old media. The distinction between media art and new media art is made within the second paradigm with reference to an analogous distinction grounded in media theory. This position seems to currently be dominant in critical and academic reflection. The conviction seems to prevail that new media art is conditioned exclusively by the same set of concepts and principles that characterize new technical and communicative media. New media art is art that uses as its creative workforce new media, which are defined as such on the grounds of media theory.

It should be noted, however, that an effort to identify new media art to a certain (sometimes significant) degree with technical media art en masse is visible in many approaches to this problem. It can be seen, for example, in Michael Rush’s *New Media in Late 20th-Century Art* (1999), where he discusses the problems of media performance, video art, video installation art and digital art, and clearly identifies new media art with technical media art in the broadest sense of the term (and, not without reason, also considers photography in the book’s introduction). [Tribe and Jana (2006)](#b-9781474207935-011-0000285), in turn, taking a similar stance to Rush, attempt to combine two historical currents in their research: *art and technology* and *media art*. Within the former, they distinguish such phenomena as electronic art, robotic art and genomic art, while among the media arts they point to video art, transmission art and experimental film as important examples. In the field of new media art that emerges from their specific integration of these two currents, Tribe and Jana focus in particular on electronic and digital art (ibid.: 6‒7). A similar position is taken by Frank [Popper (2007)](#b-9781474207935-011-0000261). Meanwhile, the editors and authors of the texts collected in the volume *Context Providers: Conditions of Meaning in Media Arts* ([Lovejoy et al. 2011](#b-9781474207935-011-0000237)) have chosen to take a broad research perspective, like their predecessors, complementing it with art–science relations.

Associating new media arts exclusively with technical media, that is, defining them in the context of media art—though one can easily find numerous examples of such an approach—is a flawed stance, if only because technical media are so diverse in nature, and, as a result, the works they produce can belong to completely different aesthetic spheres: photography, for example, has more in common with graphics and painting than with virtual reality or the internet. Placing them all within the field of new media art deprives this concept of clarity. Thus, understanding new artistic media in technical terms necessitates narrowing the scope of analysis to those media treated as new on the grounds of media theory, that is, considering their character within the narrower context of media art. As I have already mentioned, such an attitude is currently rather common among researchers of new media art. I believe, however, that the most appropriate approach to this problematic is to link the two approaches, to combine the perspective emerging from art theory with that which has its origins in media theory. This is not merely because in numerous conceptions of new media art, such as those cited earlier, we find the roots of new media art in both paradigms. It is necessary to do so in order to grasp new media art in its broader dimensions, encompassing both its new media factor and its transmedia and transdisciplinary factors. This is not just a matter of including old technical media in particular, but rather of considering selected non-technical media. Not only contemporary new media art, but also numerous works that preceded or heralded it (such as Edward Steichen’s *Delphiniums*, MoMA, NYC, 1936) often engage, alongside media technologies (and sometimes instead of them), other means, such as bio-media, which are sometimes integrated with traditional art media (as in the case of Oron Catts and Ionat Zurr’s *semi-living sculptures*) or merged with both traditional art media and technical now media (as in the case of Guy Ben-Ary’s bio-robotic installations).

New media artworks often emerge from the integration of traditional media (such as painting) and technical, even pre-digital media, as in the case of Christa Sommerer and Laurent Mignonneau’s *The Value of Art*. Such an extended understanding of the notion of new media art makes it possible to include a wide spectrum of artistic phenomena, most of which are significantly formatted by new technical media, without losing sight of those forms which, while sometimes depending only indirectly on new technical media, are largely defined by non-technical media. This is another reason to assume that new media art acquires its character from the properties it possesses rather than from the time in which the media it uses were created. It is worth noting that many of the concepts in new media art cited thus far are defined, both in relation to the media of art and media art, precisely by means of the properties it possesses and not by the time of its invention or emergence as a medium of art (although this is not always explicit).

Defining new media art in this way avoids cumbersome and unfounded considerations of the position of new media art on a timeline. It is not the moment of its appearance that determines whether a given medium of art belongs to the circle of old or new, but the properties it possesses.

The conflict between these two conceptual approaches to the “newness” of media can be resolved by building our conceptual understanding of them on an effort to identify the characteristics that define them, rather than the technologies or materials they make use of. Thus, we do not have to decide which of the two indicated paradigms is the source of and reference for new media art. Artworks that possess properties considered to be definitive of new media belong to new media art, irrespective of any paradigmatic attribution. It is this concept ‒ understanding new media art by identifying the set of characteristics, the matrix of properties, that define it ‒ that I consider to be the only correct approach.

## Characteristics of New Media Art

As I have already stated, new media obtain the attribute of “newness” not because of their privileged place on a timeline, but because of the characteristics they possess. New media are distinguished and defined by reference to a set of properties that are perceived as constitutive of them. The nature of new media art is no different. New media art shares with new media the attributes that define it.

This is also Lev Manovich՚s approach to defining new media. He ascribes five characteristics to new media, which he calls principles: numerical representation ‒ a new media object is programmable; modularity ‒ new media has a fractal structure; automation ‒ many operations in new media are automated; variability ‒ new media objects can exist in different versions, potentially infinite in number; and cultural transcoding ‒ the structure of the new media object adopts the conventions of computer data organization (2001: 27‒48). These five properties characterize both new media as such and new media art.

Manovich assumes that the emergence of new media is a direct result of the computerization of media (ibid.: 27). He argues that new media emerged as a result of the intertwining of two previously separate, independently progressive processes: the development of computing and the development of media technologies (ibid.: 25‒6). He points out that these two processes begin their parallel histories in the 1840s, when Louis Daguerre invented the prototype of the photographic camera (1839), and Charles Babbage, having first developed the concept of the differential machine (1822), then designed an analytical machine ‒ the prototype of the computer (1837). The final synthesis of these two processes, which took place through the translation of media languages into a numerical computer language, was, according to Manovich, the beginning of the history of new media. At the same time, Manovich, as he himself writes explicitly (ibid.: 52), tries not to use the word “digital” in his book, thus rejecting the possibility of considering digitality a defining principle of new media. He is right to do so, because the place of this category is on a different level than that occupied by the principles of new media he distinguishes. However, all five principles of new media, which as products of computerization are inescapably likewise determinants of digitality, are in fact characteristics of a new media material. Manovich’s concept revitalizes for the purposes of new media the traditional concept of the medium as material, casting digitality in this role.

Manovich also failed to notice or take into account in his conception yet another technological process which, like the two technologies he mentions (the analytical machine and the daguerreotype), also came into being in the 1840s, and which supplement the history of the formation of new media, introducing an extremely important aspect: the electric telegraph (1837/8). Its further evolution as part of the history of telecommunications media found its most contemporary continuation in the form of the internet (and along the way, radio, telephone and television). However, if Manovich had taken this technology into account, his picture of the prehistory of new media would otherwise be accurate, for while Daguerre՚s invention began only the history of technical visual representational media, it would have been much more difficult for him to sustain a material vision of new media. The evolution from the electric telegraph to the internet, when we place it within the paradigm of new media theory, and accordingly new media art, leads us to supplement the set of properties that define them with, first, telecommunications and, second, telematics, mobility and networking. These properties, while seemingly necessary in other theoretical concepts of new media, ultimately rule out the possibility of seeing new media as digital material.

Other scholars who have taken up the challenge of defining new media by identifying the set of properties that characterize them have, unlike Manovich, assumed, without being constrained by material requirements, that not all the properties indicated must be present in all new media objects. This position was articulated explicitly by the authors of *New Media: A Critical Introduction*, who write: “The characteristics … should be seen as part of a matrix of qualities that we argue is what makes new media different. Not all of these qualities will be present in all examples of new media ‒ they will be present in different degrees and in different mix” ([Lister et al. 2009](#b-9781474207935-011-0000234): 44).

Moreover, they also recognized that these qualities may have non-technological causes. “These qualities,” they write further, “are not wholly functions of technology ‒ they are all imbricated into the organization of culture” (ibid.). This decision proved to be important not only for the study of the social consequences of the development of new media and the formation of cybercultural orders, but also for the study of art, opening up the possibility of considering part of the field of new media art likewise those phenomena that draw analogous properties from other, non-technological sources.

The team of researchers cited above concluded that new media should be characterized by means of six properties: *digitality*, *interactivity*, *hypertextuality*, *virtuality*, *network* and *simulation* ([Lister et al. 2009](#b-9781474207935-011-0000234): 13‒44). The sets of properties proposed by Manovich and Lister et al. can be combined by replacing digitality from the latter concept with the five properties indicated in the former. It is also worth noting that two of the four features additionally identified by Manovich as accompanying variability ‒ *interactivity* and *hypermediality* ‒ are among the basic properties of new media proposed by Lister et al. The other two ‒ *interface* and *database* (in the form of an archive) ‒ are included in another proposal: the set proposed by the authors of the book *New Media: The Key Concepts* ([Gane and Beer 2008](#b-9781474207935-011-0000184)), alongside four others: *information*, *network*, *interactivity* and *simulation*. Three of these (all except *information*) are also present in the set proposed by Lister et al. *Information* (along with *network*), in turn, can be found in the list proposed by Tony Feldman (1997: 4). Terry Flew, on the other hand, repeats many of the properties identified so far, adding *convergence*, *cyberspace* and *participation*, among others (2008: 21‒37). I draw attention to these repetitions because they indicate those attributes of new media that various scholars almost unanimously accept. Their theories complement and ultimately build a shared picture of new media.

The properties most often invoked in theoretical reflections on media can be used to construct a proposed set/matrix of features defining the new media environment. These are: *digitality* (numerical representation/code, modularity, automation, variability, cultural transcoding), *interactivity*, *hypertextuality*, *virtuality*, *immersivity*, *networking*, *simulation*, *interface*, *hypermediality*, *database*, *information*, *media convergence*, and *participation*. I would also add to these the qualities I pointed to earlier as being related to telecommunications media, that is, *telecommunicativity*, *telematicity*, *mobility* and *locativity*, with *processuality* and *performativity* accompanying them in the background. This set, composed on the basis of representative new media theories, brings together both the direct attributes of new media and the qualities that define the parameters of their experience. All of them together form a matrix of new media concepts ‒ a set of basic properties that we find in different configurations in different types of new media. They also constitute the foundation for the developing art of new media. Just as in the case of new media themselves new media art also treats this matrix of properties as a source from which different sets of properties of various types of new media are grouped in different configurations and rankings.

As Manovich’s concept shows, the properties of new media are also the properties of new media objects, including artworks. Manovich addresses his concept in parallel or simultaneously with both new media and new media art. Other scholars of new media art and its subdivisions, such as computer, digital or interactive art ‒ sometimes treated (erroneously, I believe) as being synonymous with “new media art” ([Tribe and Jana 2006](#b-9781474207935-011-0000285): 6) ‒ characterize these subdivisions as well by means of properties taken from the new media matrix. At the same time, however, they also complement them with other characteristics either derived from or closely related to it. Thus, for example, Heide Hagebölling uses the following characteristics to define “interactive multimedia dramaturgy”: *non-linearity*, *spatial orientation*, *hypermedial structures*, *navigation*, *interface*, *interactivity*, *individual reception/action*, *multimediality/intermediality*, *networking*, *openness* and *hybridity*. We can find in this list three features belonging to the new media matrix ‒ *interactivity*, *hypermediality* and *interface*—and others derived from it, such as *non-linearity* or *openness*. She also enumerates characteristics related to the experience of new media, such as *individual reception*, and *navigation* ([Hagebölling 2004](#b-9781474207935-011-0000199): 1‒8). [Hope and Ryan (2014)](#b-9781474207935-011-0000205) and [Colson (2007)](#b-9781474207935-011-0000146) follow the same path. It is worth noting that all of these researchers indicate the complex and diverse nature of the art being analysed, and write about its hybridity (Hagebölling; Colson) and interdisciplinarity (Hope and Ryan). This clearly demonstrates that the multifaceted nature of new media art (which I view as an essential conceptual component) is implicit to theoretical discourses about it.

New media art has developed around modern media technologies, exploiting them and assuming their properties, merging them with qualities of traditional art, while at the same time remaining in a close relationship with science and maintaining equally significant relationships with other non-artistic and non-scientific fields of social practice. Tribe and Jana, who define new media art as “projects that make use of emerging media technologies and are concerned with the cultural, political, and aesthetic possibilities of these tools” (2006: 6), have also pointed to its transgressive character. The word “new” in the term “new media art” does not, as I would like to emphasize once again, function as a temporal denominator, but speaks to its distinctiveness; the category “new media art” should therefore be treated in its entirety as a proper name, one that refers to phenomena which possess, at least to some extent, the previously indicated characteristics.

## The History and Types of New Media Art

In 1948, the American mathematician Norbert Wiener published *Cybernetics or Control and Communication in the Animal and the Machine*. In it, he introduced a new scientific discipline ‒ cybernetics. His second book in this field, *The Human Use of Humans Beings: Cybernetics and Society*, published two years later, resonated strongly in the social sciences and humanities, as well as in artistic circles. Nicolas Schöffer, and later Wen-Ying Tsai ([Kluszczyński 2023b](#b-9781474207935-011-0000228)), for example, were fascinated by it. The ideas developed by Wiener and his followers have had a major impact on many different fields of knowledge and social practice, ranging from electronic engineering, computer science and control systems, to sociology and communication theory. They have also played an extremely important role in the transformation of art, opening up a number of completely new perspectives for it.

Firstly, cybernetics created a framework for understanding the relationship between artistic creation and scientific activity, a relationship that developed in a technological context (this context would later take the form of an environment shaped by the interaction of digital information, telecommunications and robotic technologies). A model of artistic creation was developed around cybernetics that combined science, engineering and art into a system of mutual references. At the centre of this system was the category of *feedback*, fundamental to cybernetics. As a result, scientists such as William Grey Walter, W. Ross Ashby and Gordon Pask found themselves working in the same field as artists, often on related issues: Nicolas Schöffer, Edward Ihnatowicz, Wen-Ying Tsai, Roy Ascott. Some of them, such as Pask and Ihnatowicz, displayed in their creative activities a range of interests, competencies and goals that were common to both art and science, making them perfect examples of the *third culture* postulated by C. P. [Snow (1964)](#b-9781474207935-011-0000279). Many of these individuals met in 1968 at the Institute of Contemporary Arts in London as participants of the “Cybernetic Serendipity” exhibition organized by Jasia Reichardt.

Furthermore, the dialogue between art and cybernetics led to the emergence of the cybernetic art movement. Its origins can be seen in the work of the French artist of Hungarian origin Nicolas Schöffer, whose kinetic sculpture *CYSP-1* from 1956 (CYSP is a combination of the first letters of two basic determinants of this sculpture: *CYbernétique* and *SPatiodynamique* ‒ cybernetic and spatial-dynamic) may be considered the first work of cybernetic art. Having grown conceptually and structurally out of the mechanism of feedback, Schöffer’s artwork reacted to events within its environment, entering into dialogic interactions with audience members and its environment as a whole. In this way, cybernetic art became one of the most important sources of interactive art. At the same time, developmental shifts in the control mechanisms constitutive of cybernetic art towards artificial intelligence systems and a resulting increase in works’ autonomy continued to transform cybernetic art into robotic art and further into artificial intelligence art (AI art).

Lastly, the development of cybernetic art represented a powerful challenge for aesthetics and art theory. The artworks created within its framework acquired the status of autonomous, automated subjects of action, the sources of whose activity was located within their own structure. Works created by cybernetic artists carried out performative actions in response to stimuli from their environment (sounds, light, movement). Artefacts, hitherto stable in their organization, became processes, joining the circle of *time-based arts* in the wake of kinetic art. Moreover, unlike kinetic art, they were autonomous in their behaviour. They thus forsook the idea of representation, so characteristic of the visual arts, in favour of the concept of self-representation.

For aesthetics, it was not only the new status of the artwork characterizing cybernetic art that was revolutionary, but the fact that, as a result of this change, we, as the viewers of a work, became at the same time the objects of its perception (or detection), which itself possessed a disruptive dimension that threatened to upset the existing aesthetic milieu. A further consequence of the cybernetic transformation of the concept of a work of art was a consequent transformation of the structure, properties and reference of aesthetic experience, which lost its hitherto contemplative character, acquiring in its place the structure of an event in which viewers become participants. Grounding the character of experience in feedback means that the addressee’s actions also take place within the spectrum of experience’s reference, alongside the performance of the artefact. The reactions of the audience become part of the work, constituted by the relations between the event’s component parts, and arising within the space in which they occur. The distance separating the viewer from the work of art, which is so characteristic of the aesthetic experience in its traditional formulation, and which situates both parties in essentially separate worlds, thus disappears ([Kluszczyński 2023a](#b-9781474207935-011-0000222)). In cybernetic art, the work of art and its addressee form a single, complex, hybrid whole. Jack Burnham proposed the concept of *system aesthetics* in response to the dialogue between art and cybernetics, believing it to be the most appropriate method for analysing the transformation of an object-oriented art culture into a process-oriented one ([Burnham 1968b](#b-9781474207935-011-0000140): 30‒35).

By abandoning representation in favour of self-presentation, cybernetic art simultaneously replaced an anthropocentric perspective with a robotic one. By making robots a model for a work of art, it had chosen the notion and task of creating life instead of representing it. The adopted robotic model and the resulting creative context mean that we are dealing here with a vision of post-biological life. It also problematizes the traditional humanist stance and, further, heralds the inclusion of cybernetic art in the process of constructing post—or trans-humanist orders.

I consider robotic art to be an extension or perhaps a direct transformation of cybernetic art, as I have already mentioned. However, the above observations lead us to stake out even more far-reaching horizons for cybernetic art. It is possible to see its continuations in the form of an art of artificial ecosystems, an art of artificial life, bio-cybernetic art and bio-robotic art ([Kluszczyński 2023b](#b-9781474207935-011-0000228)). The latter, in turn, also forces us to speak of its opening up to bio-art and other forms of bio-media art. Rooted in the radical transformations of art in the latter half of the twentieth century, and initiating or co-creating numerous neo-avant-garde tendencies, cybernetic art built the foundations for the further development of new media art.

Apart from cybernetic art, the second type of new media art appearing at the beginning of its history was oscilloscope art. The first such works appeared as early as 1950, thanks to Ben Laposky and Peter Keetman. The specific character of works of this kind, which integrate two different art media in cooperation, should be particularly noted. The images generated on the screen of an oscilloscope are then recorded with a photographic camera, as seen in the case of the two artists mentioned above, or with a film camera, and only in this final, hybrid form are made available to the public. Films using oscilloscopes were made by Norman McLaren, Hy Hirsh and Mary Ellen Bute. Oscilloscope art developed in a transmedial and transdisciplinary space, involving technoscience as a partner in the latter dimension. Things were no different in the case of cybernetic art, where, in addition to its interaction with science (cybernetics), we also observe the constitutive relations of the cybernetic medium with other art media: with kinetic art and sculpture ([Burnham 1968a](#b-9781474207935-011-0000137)). All three factors of new media art—newmediality, transmediality and transdisciplinarity—have thus been present in this field and its genres from the very beginning of its history.

The following decade witnessed the beginnings of computer art, initially in the form of graphics and animation, and later computer-designed sculptures as well. Here, too, the computer medium functioned in cooperation with other art media. The new media art that arose out of these interactions emerged out of their close ties to computer science and the technosciences, and not only because they were essentially dependent on scientific and technical development. Many works considered to be early examples of computer art were created by scientists-turned-artists like Herbert W. Franke, Jean-Pierre Hébert, Hiroshi Kawano, Frieder Nake and Georg Nees, whose laboratory or university research activity played a direct or indirect role in their genesis. In the United States, the scientific and engineering communities played an extremely important role in this regard; an important source of early computer art was Bell Laboratories, where Charles Csuri, Bela Julesz, Ken Knowlton, A. Michael Noll, Lillian Schwartz, Edward Zajec and others worked. Works by Julesz and Noll were featured during the first exhibition of computer art in the United States, titled “Computer-Generated Pictures,” held 8‒April 24, 1965 at the Howard Wise Gallery in New York. Artists from scientific circles were subsequently displayed alongside artists who had practised traditional artistic disciplines before entering the world of computer-generated new media art, such as Manfred Mohr, Vera Molnár or Roman Verostko. Together, these artists formed a circle referred to by Verostko as the *algorists*. Parallel to this work in the visual and audio-visual arts, experiments were also being carried out at that time in the field of computer music and literature ([Dietrich 1986](#b-9781474207935-011-0000158)).

Video synthesis art was being developed alongside computer animation by artists such as Stephen Beck, Nam June Paik, Dan Sandin, Woody and Steina Vasulka, initially using analogue and later digital devices—synthesizers. From a contemporary perspective, three types of new media art can be identified here: *oscilloscope art*, *computer animation* and *video synthesis* *art*. These are often seen as a single area of artistic practice, just as cybernetic art is often combined with certain varieties of robotic art.

In the following years, further types of new media art emerged. These were rooted both in the dynamic development of media technologies and in the increasing number of transformations of new media forms and the development of their connections with both other kinds of art and with non-artistic fields of social practice. To conclude this section, I would like to list the most important types of new media art (and their forerunners), that is, those most often indicated in reflections on this area of practice. I have organized them on the basis of their status and the functions they perform in the world of new media art.

*Forerunners:* Kinetic Art, Process Art, Performance Art, Conceptual Art, Art and Technology. Although these types of art do not belong to the field of new media art, I refer to them here because they preceded it (logically, not necessarily chronologically) and were instrumental in its development. They are, in a sense, present in new media art because they all share certain fundamental properties: they challenge the object status of the artwork, transform it into an event, emphasize the causal significance of the viewer (collaboration and participation) and highlight the importance and role of technology in art.

*Media-based:* Oscilloscope Art, Robotic Art, Bio-Robotic Art; Holographic Art, Laser Art, Video Processing Art, CD-ROM and DVD-ROM Art, Virtual Reality Art, Augmented Reality Art, CAVE Art, Video Game Art, Machinima Art, Internet Art (Mail Art, ASCII Net Art, Web Art, Browser Art, Virus Art, Social Media Art). These types are rooted in a specific new technical medium or intermedium, and their basic properties are linked to the specific, unique characteristics of a given new media environment.

*Attributes-based:* Cybernetic Art, Bio-Cybernetic Art, Telecommunication Art, Generative Art, Evolutionary Art, Interactive Art, Hypermedia Art, Networked Art, Mobile Media Art, Locative Media Art, Sound Art, Artificial Intelligence Art, Artificial Life Art, Bio-Art, Genomic Art, Transgenic Art, Nanoart. The types grouped together here are all organized around the basic characteristics defining them. An artwork assigned to a particular genre may also belong to other genres linked to specific media (interactive art, for example, may include works from VR Art, Video Game Art or Internet Art, as well as interactive installations, interactive films or forms of interactive theatre or architecture). The tendencies that developed most intensively within these new media art genres grouped here were those that utilized and developed its most transgressive aspects: transmedial and transdisciplinary.

*Metamedia:* Computer Art, Digital Art, Electronic Art. I refer to these as *metamedia*. Their media properties provide the foundation for many other types of new media art, which means that within each type, there are works belonging to numerous new media art genres, such as Computer Graphics, Computer Animation, Digital Video, Electronic Literature.

*Function-based:* Software Art, Glitch Art, Tactical Media Art, Hacktivism. The types I have assigned to this group have been selected both for their aesthetics and for their strategies and objectives.

The differences found among and within all these different types of genres are also essentially produced by the relationship between the three defining aspects of new media art: *newmediality*, *transmediality* and *transdisciplinarity*. These interrelationships not only give rise to new media art, and shape its history, but also define specific types of new media art and individual artworks.

## The Main Factors of New Media Art

The active presence of new media in social contexts has initiated numerous and profound cultural changes, including those taking place in the field of art. Transgressivity, hybridity, transmediality and transdisciplinarity are among the aspects of contemporary artistic culture where the emergence of new media technologies has played a key role. Considering the genesis, properties and socio-cultural circulation of new media, I distinguish three factors of the field of new media art: *newmediality*, *transmediality* and *transdisciplinarity*. Their mutual interactions gave rise to new media art and shaped its history. The order in which I discuss them here is logical rather than chronological: there is no temporal order in these artistic practices. We can only speak of the dominance of certain attitudes and related tendencies in particular periods or particular works, which may influence the visibility of particular factors and their hierarchies at a given moment.

## Newmediality

When we consider new media art exclusively in terms of this first aspect—its *newmediality*—we look solely at how it was shaped through the use of new technical media. They are the source of both the tools that shape new media art, and the basic attributes and aesthetics that define it. All technical media interact with each other. Within this process, *newmediality* comes closer to a second factor: *transmediality*. This rapprochement, expanding but also intensifying and differentiating the various dimensions of newmediality, yields desirable consequences for new media art, as new and valuable artistic possibilities emerge, including new structures (such as networked VR) and properties associated with them (such as collective immersivity).

The dynamics of artistic processes dominated by new media are shaped, on the one hand, by artists’ analyses of media and their various uses or overuses of it, and, on the other, by scientific and technical inventions that have impacted the world of new media. Here, in turn, the factor of *newmediality* is supplemented by a third, *transdisciplinary* factor.

The claim that the first creators of computer art came from the world of science has its justification in the fact that the development of new media art has been, in the context of newmediality, driven by technical-media inventions and their increasing availability. Computers, before they entered the world of art, had found a home in the world of science, where, in their interactions with scientists, they unexpectedly generated processes of not only scientific, but also artistic value (these processes opened up a new chapter in the transdisciplinary relations between art and science). Advancements in the field of digital technology, which have contributed to the development of and diversification within the field of new media and their social impact, have also had an enormous impact on the development and transformation of new media art.

Newmediality is the reason that successive technoscientific and media inventions, as well as their evolution and increasing capabilities, have played such a key role in the rapid development of new media art and in the formation of new types and trends within it. In various periods of its history, certain technologies have attracted particular interest and attention from artists, either because of the new artistic and research perspectives they opened up, or because of the perceived possibilities they offered for opening up new realms for creative exploration. Numerous inventions within this discipline—multiple interfaces, data recording and compression technologies, virtual and augmented reality technologies, broadband internet and the World Wide Web, machine learning and artificial intelligence—have all stimulated waves of interest among progressive artists, leading to the development of new types of new media art and influencing which forms achieved momentary domination within this dynamic field. Interactive art, installations using various forms of data recording, virtual art, internet art, generative art—all of these emerged as much as a result of the development of artistic ideas as due to the availability of certain tools and technological possibilities.

The artistic significance of different types of new media art has changed over time along with the advancement of technology. Virtual reality art, for example, which in the 1990s aroused the interest of many outstanding artists, such as Monika Fleischmann and Wolfgang Strauss, Brenda Laurel, Maurice Benayoun, Michael Scroggins, Char Davies, Eduardo Kac, Ulrike Gabriel, and which resulted in a number of important works, faded from view in the following decade, only to return now with intensified force in the works of numerous artists of various ages. Additionally this art has also become networked (internet VR art has appeared) and has contributed to increasing interest in the art of augmented reality, all thanks to the great strides made in technological advancement.

The dynamic nature of the transformation of this new media art factor, which is expressed in the transformations technical new media have undergone and in the expansion and intensification of the relations that connect them, also underlies the developments that have taken place in its other factors. In turn, the intensification of the processes through which transmediality and transdisciplinarity are expressed, the constant search for new possibilities for using newmediality for specific artistic purposes, strengthens the position and importance of the latter in the world of new media art. All three factors together—and multiplicity, diversity and the effectiveness of their interrelationships—determine the dynamics of development and the social position of the overall field of new media art.

## Transmediality

The notion of *transmediality* ‒ the second factor considered here ‒ conflicts to some extent with the category of *postmedia*, commonly found in discussions of new media art and contemporary art. In order to properly present the nature, role and significance of the transmediality factor of new media art, it is also necessary to look at the concept of postmediality and the mutual relations linking these concepts.

The concept of postmediality has been the subject of a variety of analyses by numerous researchers (see, for example, [Krauss 1999](#b-9781474207935-011-0000231); Apprich, Berry Slater, Iles and Lerone Schultz 2013; [Chierico 2016](#b-9781474207935-011-0000143)). It is sometimes used, like Quaranta does, as a tool for undermining the significance and status of new media art categories (2013: 17‒18). New media culture or media in general, as Peter [Weibel (2005)](#b-9781474207935-011-0000294) puts it, would within this research perspective give way to postmedia culture. But what in fact are postmedia? Quaranta and Weibel, in spite of the apparent affinity between their attitudes and their both proclaiming the birth of the postmedia era, clearly differ in their assessment of the importance of new media in relation to other components of the postmedia world.

What I call the transmedia factor of new media art—with this category supplanting the notion of postmedia—is somewhat similar to the way in which this latter term is defined by its promoters. I juxtapose these two concepts here to show what the categories of postmedia and transmedia have in common and what divides them. Weibel writes about the mixing and blending of media as the foundation of the postmedia condition of the art world. I also see artistic transmedia as a result of the convergence, mixing and hybridization of traditional media art, technical media art and new media art, as well as a comparative levelling in terms of the importance and rank of these three areas. However, unlike researchers who regard postmedia as a phenomenon belonging exclusively to the field of art, I also see in transmedia the result of a process which has taken place in the media environment as such, that is, technical means of communication. And what is more important, I do not see in transmediality a process or formation which has emerged to replace new media art, whether in a chronological or logical sense, as Quaranta sees postmedia art. I interpret transmediality as a factor of new media art, one that has co-created it from the very beginning of its history. I have pointed this out in my analysis of cybernetic art and oscilloscope art. Transmediality has now spread throughout contemporary art, which has grown significantly closer in character to new media art.

We can consider the issue of transmedia from two perspectives: that of the media (technological) environment and that of the art world. With regard to the former, the concept of transmedia needs to be considered in relation to two issues.

Firstly, transmedia no longer refers to individual media, but to complex media environments in which, as an element of wider convergence processes, media have come together to form a complex whole, offering a set of properties and possibilities that were once dispersed among individual media. On the other hand, as a result of the development of the divergence processes that accompany convergence, transmedia are breaking up into numerous differentiated environments which function in a variety of parallel creative and communicative processes, differently from the individual media they superseded. These divergence processes co-create the platform and principle I wrote about earlier, namely that individual new media can only embody some of the properties that together characterize a holistically conceived new media environment. The divergent world of art offers each of its elements the possibility of being an example of the whole.

Convergence is accompanied by a process of remediation, that is, moving in the same direction, ultimately, towards a media synthesis ([Bolter and Grusin 1999](#b-9781474207935-011-0000134)). In this way, convergence also embraces not just new media, but old media as well. However, it is the emergence of new media, their properties and the tensions they have introduced into the media system that have dialogized and dynamized the whole system, triggering processes of remedial hybridization. The properties I have termed *the new media matrix*, or the new media as such, have turned out to be a source of transformation of both the media system overall and its socio-cultural environment, initiating multi-directional processes in which old media became new, and new media discovered their sources and sometimes their current inspirations, in the old.

Secondly, transmediality is accompanied by a universality of access, ease of use and the obviousness of applying media technological possibilities (ubiquitous computing), which shifts the focus from media and their challenges and technical possibilities, to the cultural consequences of their social functioning and their interaction with a diverse environment. Contemporary social media saturation strips new media of the magic once felt in them, shifting our attention to what we gain from their use.

Things are no different with transmediality in the art world. Here, too, we are dealing with a fusion of media, this time of art media. The hybridization of art media combines traditional media, such as painting or sculpture, with technical media: photography, radio, film, video and new media, whether interactive or virtual, networked or geolocative, like in the works of Masaki Fujihata ([Kluszczyński 2017](#b-9781474207935-011-0000214)).

However, unlike the media order, where the old media are adapted to the cybercultural reality of the new media, in the art world, it is the new media that are to be ennobled and then mixed with the old ‒ traditional ‒ media. It is in this way, through integration, that they become linked to both traditional media and the art world. At least this is how it looks from the perspective of the artistic mainstream. From a new media point of view, this is more of a process of “modernizing” the traditional art world. However, if we refrain from privileging either side, we can say that what we are dealing with in this process is the reconciliation of two diverse, different visions of art.

In fact, the fusing of technical media and traditional media characterizes the whole history of technical media art. This process began with photography, which sought to gain acceptance for its artistic aspirations through an association with painting and drawing, thereby smuggling itself into the world of art disguised as a medium that was already present in it (pictorial photography). Thus, in the world of artistic creation a specific mode arose for developing the art of technical media. As a result, they acquired a two-plane structure. On the first, we find properties, structures and forms resulting from the technological conditions available in technical media art. On the second are properties taken from the traditional arts, that is, those that are generally engaged in interactions with the attributes of technical media. These interactions are constitutive of the artistic status of the work. A dialogue between these two spheres usually defines the aesthetics of works produced in this mode.

Such a duality invariably continues in technological art today. And although it takes on a different form nowadays ‒ the technical character of art media no longer arouses particular controversy, and art itself seems to remain in a symbiotic relationship with technology ‒ this principle continues to remain relevant. Lev Manovich, for example, in characterizing new media art, drew attention to how its properties are configured, which is particularly important in terms of its aesthetic character. New media art has, in his opinion, a similarly two-layered character. The first layer consists of cultural determinants, such as *encyclopedia*, *short story*, *plot*, *composition*, *point of view*, *mimesis* and *catharsis*. The second layer includes aspects and components derived from computer technology: *process*, *packet*, *sorting*, *matching*, *function*, *variable*, *computer language* and *data structure* ([Manovich 2001](#b-9781474207935-011-0000240): 46). As a result, a specific form of computer art (and culture) emerges: a synthesis of cultural attributes and meanings and computer properties, traditional humanistic rules for modelling the world, and computing principles and resources that achieve this in their own distinct way.

We can therefore say that technical media art, in the broad sense of the term (media and new media art), is usually or most often shaped by the interaction of specific media and new media characteristics that take on artistic properties, thus embodying an integrative dialogue between technology and culture.

Transmediality is an extremely important factor of new media art. Newmediality is characterized by its creative instrumentarium, and is present both in the structure of artworks and, in particular, in their experience. The transmedia factor, on the other hand, apart from enriching and broadening the spectrum of a work’s properties, and its artistic and aesthetic potential, also overcomes the seclusion imposed on it by newmediality, reduces the distance separating it from the old technical media and opens it up to interaction with traditional, non-technical media, without giving up anything that has characterized and distinguished it thus far.

Transmediality is more than just a defining factor of new media art. It is the means by which the world of artistic creation is linked with new and traditional art media. But we are not talking here about attaching one to the other, let alone subordinating one to the other. Their interactions lead to the emergence of a new common plane, one that is transgressive and hybrid, potentially integrating the world of artistic creation as a whole. Thus, in a sense, it plays the role ascribed to the postmedia perspective, but without the mistakes that were made there.

## Transdisciplinarity

Whereas transmediality is grounded in intra-artistic relations, in particular, those with technical media and between traditional artistic types, transdisciplinarity broadens the set of interacting disciplines and undermines the boundaries between them. Transdisciplinarity emerges as a result of the processes of deconstruction and transgression, which disrupt not only the previous artistic order, but the cultural system as a whole. Earlier visions of the institutional order are deconstructed, and individual fields of social practices merged. As a result, transgression becomes a fundamental process in the building of a new cultural order.

The transgressive dimension of artistic practices brings about a weakening, undermining or questioning, or even an abolition, of the boundaries marking the culturally defined territories of art. Yet, this concerns more than just the borders between art disciplines. These began to be undermined in the nineteenth century, and were essentially invalidated by the historical avant-gardes and neo-avant-gardes in the following century. What we are talking about here are the boundaries between art and the environment within which it operates. These were also undermined by the most radical avant-garde trends, but it was transdisciplinary art that ultimately made them irrelevant. The numerous forms of transgression occurring in artistic work today have abolished the borders separating art from other fields of practice, putting it in direct relations with other spheres of social life and the concepts, methods of action, tools and products characteristic of them, opening up new possibilities for art. Transgression thus supports a deconstructive posture, joining it as a key factor in the hybridization of art. Borrowing from Giorgio Agamben’s reflections on contemporary post-identity forms of community (1993), I can say that through its manifold transgressions, art has lost its former identity, grounded in common properties, which had already been systematically weakened by avant-garde activities, ultimately becoming an open field in which every work proposed and accepted by art institutions is an example.

Deconstruction and transgression have turned out to be two aspects of the same complex process of transformation, one in which art is parting with its inherited identity and opening up for itself a horizon of new, open creative possibilities.

In the vast field of new media art, where transdisciplinarity plays a decisive, constitutive role, I identify two tendencies that I consider particularly important for its contemporary face: SciArt and Critical Art. Both are founded at the interaction of all three factors of new media art. Both of them also involve *artistic research*, treating the creative process not only as a means of creating specific products/works that evoke artistic experiences; in this case, creative processes and their products/works of art are also a means of creating knowledge. Both aspects of the work created in this mode—artistic and cognitive—are closely related, constituting an inseparable whole. In some cases, this process of knowledge creation also involves its addressees. Knowledge is then created collectively and dispersed or distributed in character. Audience participation may occur at the stage of the creation of a work or during its reception in the form of participatory experience.

The history of SciArt overlaps with the history of new media art. Since the very formation of the new media paradigm, it has been intensively building the relations between art and science. One might even say that new media art was born out of these interactions, and not only because it emerged from research into communication and media theory. A very interesting early illustration of this is a series of projects by Sherrie Rabinovitz and Kit Galloway produced under the common title Aesthetics Research in Telecommunications (1975‒7); equally interesting later examples, resulting from further developments in telecommunication technologies, are provided by the work of Monika Fleischmann and Wolfgang Strauss, including *Energy Passages* (2004), *Media Flow* (2006) and *Performing the Archive* (2007).

Other fields of science, such as mathematics and computer science, were also present here from the very beginning, providing the basis for the growth of algorithmic works. These included graphics and computer animation by Herbert W. Franke, Frieder Nake and Georg Nees, and cybernetics (otherwise parallel to communication theory), from which a dialogue emerged that led to the first creative currents of the new media age: cybernetic and robotic art, the works of Nicolas Schöffer, Edward Ihnatowicz and later those of Simon Penny, Bill Vorn and Chico MacMurtrie. These early manifestations of art’s interaction with science, initiated in the 1950s and 1960s, were simultaneously embedded in the context of engineering and technological knowledge and practice. Subsequent relations between art and science moved even further into the world of science, reaching towards such research areas as the life sciences, neurology, genetics, nanotechnology and artificial intelligence.

The SciArt trend thus marks a vast and extremely diverse realm of contemporary artistic practice, symptomatic of the contemporary world. The numerous tendencies that constitute it, such as bio-art, neuroart, bio-robotic art, nanoart and artificial life art, are characterized by their deep transdisciplinary hybridity. The number of artists who should be mentioned here is immeasurable. I will only mention by way of exemplification (in alphabetical order) artists such as Guy Ben-Ary, Oron Catts and Ionat Zurr, Harold Cohen, Joe Davis, Ken Feingold, Ulrike Gabriel, Eduardo Kac, Marion Laval-Jeantet, Jill Scott, Karl Sims, Christa Sommerer and Laurent Mignonneau, Robertina Šebjanič, Stelarc, Paul Vanouse and Victoria Vesna.

While developing its interaction with science, art has remained heavily engaged in the humanities, in particular cultural studies and social studies. Art is increasingly focused on reflecting on such issues as contemporary socio-cultural orders, the Anthropocene and ecology, migration, nationalism and totalitarianism, human rights, racism and exclusion, violence and civic self-organization. Artists assume both an analytical and critical stance at the same time, bringing invisible political processes and relations to the surface, undertaking deconstructive, subversive, critical actions in their art, the results of which lend support to underprivileged or persecuted social groups and sustain hope for social change. This is why I have chosen the category of Critical Art to describe this field of new media transdisciplinary art. Another term that could be used here is “new media artivism.”

The concept of Critical Art was already functioning earlier in reflections on contemporary art, irrespective of the context of transdisciplinarity and new media art indicated here. However, it is only within this framework that we can discern the qualities that most fully define this current. Earlier considerations of the notion of critical art made reference to Michel Foucault and pointed to the subversive but also analytical character of both Critical Art and the techniques it used. Directing attention to the transdisciplinarity of critical art brings out its structural and cultural dimension, not only its newmediality and transmediality, but also its transgressiveness and hybridity, thus placing it within the broader framework of processes that characterize contemporaneity.

Critical transdisciplinary art makes free use of transmedia tendencies, developed in the context of new media art, to mix technical and traditional media. The works created as a result of this strategy are very diverse in genre and character. As in the case of the previously cited works from the field of SciArt, works from the circle of Critical Art display a wide variety of creative strategies. Differences between artists’ creative stances concern not only the media used and the topics addressed, but also their working methods.

Lynn Hershman Leeson’s interactive installation *Room of One’s Own* (1990‒93) explores the issues of voyeurism, surveillance and social domination. In making reference to the works of Virginia Woolf, the artist invites the audience to participate in a performance in the form of a peep show, where a woman is turned into an object to be watched and controlled. Participation in this patriarchal staging initiates a subversive analysis of the orders of power, discrimination and exclusion.

Simon Robertshaw in *The Order of Things* (1996) addresses issues related to biological determinism, bio-power, eugenics and its contemporary continuations. He analyses the methods that science creates to determine people’s ways of perceiving themselves and reality, as well as the consequences that emerge from this. He combines photographs, video projection and interactive objects in a vast hybrid work, offering viewers the opportunity to analyse their own perceptions and understand them critically.

Luz María Sánchez has dedicated her work, a mobile phone application linked to a customized website, *Vis. [un]necessary force\_3* (2017‒21), and made it available to its direct users: the Rastreadoras group in Mexico, who are searching for the remains of their kidnapped and murdered loved ones. This audio-visual cyber-cartographic work is both a commemoration of the victims and a tool ‒ a database for the construction of memory, oral and audio-visual history. The data collected during the search expeditions are scientifically systematized here. The work also serves to empower the participants and strengthen their sense of community. *Vis. [un]necessary force\_3* is a transdisciplinary, collaborative artwork that builds on the foundation of ongoing research. In the works of Sánchez, as in the case of some other artists, the critical approach and SciArt tendency merge with each other ([Kluszczyński 2021](#b-9781474207935-011-0000217)).

In the examples used in my considerations in this part of the article, only a few of the new media artworks displaying transdisciplinary tendencies are situated in the field of Critical Art. However, many artists are active in this field, just as in the case of SciArt. They have created works that are diverse in terms of both media and structure. Shu Lea Cheang, Gina Czarnecki, Electronic Disturbance Theater, Harun Farocki, Hito Steyerl, VNS Matrix, Krzysztof Wodiczko, and the Yes Men are only a few of the artists active in this field, with their activity reflecting its diversity.

Thanks to its transdisciplinarity, the new media art enters into significant relations with other, non-artistic disciplines of social practice, such as science, the humanities, politics and social activism. The only possible form of such integration is the emergence of a new plane of cooperation, and the formation of new languages, methods of action, values and aesthetics. Transgressiveness and hybridity reach here their highest level of complexity.

## Conclusion

All three factors and their associated orders—newmediality, transmediality and transdisciplinarity—together with the currents, tendencies and attitudes which emerge as a result of them, jointly define the area of art organized around new media, where the relations between artistic creation, technology, science, humanities, political and social activism play a constitutive role. These factors do not constitute successive stages or phases in the development of new media art, however. As shown by the first chronological currents ‒ cybernetic art and oscilloscope art ‒ these factors have invariably accompanied each other from the very beginning of its history, creating together a comprehensive, defining framework for new media art. I consider the co-presence and mutual interaction of all three factors to be the basic determinant of this field. These essential, defining connections also make artistic research the most characteristic and most valuable artistic practice in this field. Moreover, the creative potential of new media art, and the spheres of reflection and creative practice that arise from these three integrated, defining factors, make it one of the most important fields of activity for contemporary artists today.

For a very long time in its history, new media art drew its progressive impulses and driving forces primarily from the milieu of independent artists, rather than from the institutional art world. Of course, technological and scientific progress and the development of the media also played an important role here, but mainly in defining the available possibilities for creative choices and in creating environments for their realization, rather than for endowing them with a transformational character and path of development. This situation, however, seems to have changed somewhat in the last decade, due to the deepening autonomy of technologies and newly available intelligent (and, in their own artificial way, living) tools, which lead us to ponder anew the status, character, place and role of art and creative processes in the context of this transforming reality. An important role here is also played by the increasing opening up of the institutional art world towards new media art. Technology, even in the form of NFTs, is gaining increasing importance, and new media art is playing the role of an avant-garde inspirer and active participant in these events. Meanwhile, it is also a critical/research agency that reflects on their course and on their various consequences, both for the sake of art and the world as a whole.

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Net art is a term used for art made in the context of the internet, whereby context is interpreted broadly to also include offline components, objects and events. The role of the internet in net art ranges from technological to conceptual. Although the term itself was first used in the mid-1990s when the internet first became popular, it also includes works of art and art practices that existed earlier as well.

Art practices involving the internet and related networks are known under a variety of terms depending on historical contexts. They can be called telecommunications art, telematic art, internet art, net art, net.art, web art, network art, networked art, digital art, new media art and post-internet art. Of all these terms net art is the most generic, allowing for a broad spectrum of practices. Sometimes, especially in early publications, different terms are used interchangeably. This does not mean they can safely be exchanged since subtle differences of meaning manifest within each term. Web art for example delineates art specifically made for the web browser, whereas the other terms each cover a wider scope of art practices. The internet is a sort of large infrastructure for which various types of applications are developed, of which web browsers are only one type.

Arguably, net art points to a transition in the arts in which a renewed interest in technology in art, caused by the influence of easily accessible consumer media tools, becomes apparent. An abundance of forerunners mentioned by several historians and theorists seems to support this theory. Among early twentieth century art movements and practices linked to net art are, for example, mail art, Fluxus, conceptual art, expanded cinema, Situationism, media activism and video art.

The development of net art appears to move in tandem with that of digital computer-based network technologies. As network technology matures and starts to invade many aspects of society, net art practices become less technology oriented. To illustrate this point: early net artists focused more on the creation of network access and communication, whereas, after the big surge in internet use in the new millennium, net art practices have become increasingly diverse, to the point where the internet became more context than medium. Over the years net art shows the influence of digital networks on the arts in a variety of ways in the works and practices of several generations of artists existing alongside each other. What follows is a selective history of net art to highlight the diversity of practices, how net art evolved and how different net art practices relate to socio-technological developments.

## Early Computer Networks

To recognize the various forms in which net art exists we have to first understand a little bit about the history and basic structures of the internet. What we know as the internet today is technically an assemblage of various networks and media technologies that more or less operated separately until the 1980s when the TCP/IP protocol, a set of standardized rules that allow computers to communicate on a network, is adapted globally. Yet, culturally the advance of a large-scale, global network was anticipated already at the dawn of the twentieth century, when radio and cinema sparked the imagination of writers and artists. The early network science fiction and dreams of the likes of E. M. Forster, George Orwell or the Italian Futurists are traded for something more up to date when computer science made a big leap after the Second World War. In particular, a popular interest in cybernetics seems to have inspired a brief surge in exhibitions around art and technology in the second half of the 1960s. With titles such as “Information” or “Software,” these exhibitions herald the dawn of the use of computers and digital media networks in art. It is not until the end of the 1970s that artists get their hands on actual computer networks. This starts in computer timesharing networks.

Computer timesharing is, like the name suggests, a way to share access to a large mainframe computer. Personal computers barely exist before the early 1980s. In “Internet or the Ideal Scientific Community,” Patrice Flichy writes that in timesharing “machines would carry out several tasks simultaneously, thereby giving all users the impression they were using the computer independently” ([2000](#b-9781474207935-012-0000177): 158). Timesharing precedes the TCP/IP protocol of the internet and as such is the beginning of using the computer as a communication tool. Early adopters of the new network technologies experience timesharing and the internet as a similar, if not the same, phenomenon.

## **Early Net Art:** **1980–90**

Between 1970 and 1980, when the internet is only accessible for the US military and a few US universities, international digital networks are only offered by commercial timesharing companies and their services are expensive. In this early phase when the general public and artists have no access to computer networks, informal access, therefore, is key. The first artist network starts almost by accident when the Canadian new media artist Norman White gets access to a global messaging network through his friendship with Robert Bernecky, a programmer for I. P. Sharp Associates (IPSA), a computer timesharing company based in Toronto. White and Bernecky pass the invitation on to friend and fellow Canadian artist Bill Bartlett, who will be seminal in organizing two major online events in 1980. Bartlett organizes the first online artist symposium: “The Artists” Use of Telecommunications’ at SFMOMA. Since there exists no artist online network yet and intercontinental telephone calls are very expensive, the organization of this online conference has to happen via postcards. Excited by the fast communication and wide reach of the network Bartlett collaborates with Vienna-based Canadian artist Robert Adrian to establish the first online artist network ARTEX. It has about thirty to thirty-five members between 1980 and 1989 and a core group of users of just ten. Members live in the US, Europe, Australia and Japan.

Works made through the first online art network develop within an existing interdisciplinary art practice in which artists use any media they can get their hands on. In the 1970s artists make art for television and radio, occasionally have access to satellites, and begin using Slow-Scan TV (SSTV) as a medium. SSTV is a technology through which still images can be sent via radio waves or telephone. It is best known for the transmission of images between the moon and earth. Since the terminals used for accessing mainframes at this time are still teletypewriters without screens, computer communication is only visible through text printouts, and SSTV (and later also fax machines) complement the computer network visually. Works of art in this context have the shape and feel of an event or performance, with live performances on each connected site, sound sent through telephone and radio, visuals sent through SSTV and fax, and the physical text and the smell of ink emanating from the teletypewriters and thermal printers. The apparatus for sending SSTV isn’t always legal to use and has to sometimes be smuggled into the country.

The use of computer networks in art starts in a semi-legal void and as an addition to a range of media and networks, which at times are used simultaneously, at other times in varying combinations, resulting in a sort of media ecstasy during events. In the 1984 publication *Art Telecommunication* British artist Roy Ascott, a member of ARTEX, writes lyrically: “Networking cross hatches all existing structured institutions and links diverse participants who are in metaphysical harmony … networking is the most vital, intelligent, integrative organizational mode on our turbulent social scene” ([Grundmann 1984](#b-9781474207935-012-0000196)). From 1983 the term “telematic art” starts being used alongside “telecommunications art,” due to the influence of Ascott’s writings.

ARTEX serves as a good example of what would be an important aspect of net art for decades to come, namely online artist-run initiatives. In these, the network is used to create a sort of online independent art space, where artists meet, exchange ideas, create works and organize events and exhibitions. These come in the shape of the mainframe timesharing network, BBSs (Bulletin Board Systems), Usenet groups, mailing lists, websites, shared blogs, social media pages and more, mostly depending on the technology at the time of their inception. New network technologies generally do not replace earlier ones, but rather different technologies coexist over time. Even computer timesharing still prevails today but is predominantly used for cloud computing by large companies.

Online artist-run initiatives tend to be rooted in conceptual or activist approaches to art. Early online art networks like ARTEX, ACEN, BIONIC, The Thing, nettime and Rhizome could be seen as a kind of social media “avant la lettre.” ARTEX co-founder Robert Adrian, for example, is influenced by the anti-institutional and collaborative practices in mail art and conceptual art. US artist Mark Tribe describes his online art platform Rhizome as a social sculpture, after Joseph Beuys, as does The Thing founder Wolfgang Staehle. US-based artist and ACEN member Judy Malloy draws a direct line between 1980s online art networks and social media in her 2016 book *Social Media Archeology and Poetics*. Most of these initiatives, with the exception of online art magazine, gallery and network ACEN, are initially conceived as artworks in a mixed online/offline context involving a large socio-cultural sphere. Online artist initiatives tend to have members involved with an offline art space, institution or collective engaging with a local community, expanding the reach of the network beyond its members and online communication alone.

## **BBS Culture:** **1985–95**

Slowly but steadily network technology becomes more available through the rise of more computer timesharing companies and more accessible hardware. To use computer networks remains expensive for artists because most requires dialling into a remote server. As the 1980s progresses various online artist initiatives come onto the scene. The development of the personal computer with screen makes the combination of media we saw in telematic or early net art less necessary, leading to more purely online events and works. In these, text is still more important than visuals. Going online is by 1986 a matter of connecting a desktop computer with green-on-black screen to a telephone modem. The printer becomes less central to online exchanges, making the latter appear more fleeting, feeding the idea of immateriality in digital computing.

Influenced by the work of Bartlett and Ascott, Carl Loeffler, founder of artist-run space La Mamelle and art magazine *Art Com* in San Francisco, moves both his art space and his magazine online in 1986. Many text-based works are produced for Art Com Electronic Network, or ACEN for short. ACEN uses the infrastructure of influential California-based bulletin board system (BBS) network The Well that started a year earlier. A BBS is a technology similar to timesharing. Instead of a huge mainframe, the server can now be a personal computer. The Well, short for Whole Earth ’Lectronic Link (1995–today), is an influential online community in which almost all early network gurus, writers, theorists and artists around Silicon Valley participates.

In the ACEN gallery several art projects take shape, mostly text and code based. As within ARTEX, works vary from being deeply interactive (involving open audience participation or collaborative action) to more static (the presentation of a work produced by one or more artists). An example of the first would be Judy Malloy’s *Bad Information*, for which she asks fellow ACEN members to provide untrue or silly messages. The collection is later made accessible as a database in the ACEN gallery. A different approach is taken in John Cage’s *The First Meeting of the Satie Society*. For this Cage collaborates with two programmers, Jim Rosenberg and Andrew Culver, to develop a sort of generative art project. Software alters texts by famous authors so they appear to praise or describe Satie’s music, including selections from the Book of Genesis and a response from Satie himself, compiled from selected quotes of the composer. The timing of the messages makes it seem as if the “authors” are in real-time interaction.

In the meantime, outside the United States more activist art practices develop around the new networks. The critical approaches in art and theory from the 1960s and 1970s that influenced Adrian and others blends with the rise of the hacker community, which has ties with different artists, theorists and activists around the world. Inspired by both, the German artist duo padeluun and Rena Tangens start the BIONIC mailbox (mailbox is the term used for a BBS in Germany) in 1989. Through its link with the German hacker community, BIONIC is used by both artists and activists.

The Italian BBS scene is particularly lively, as contrast and refuge to a Berlusconi-dominated Italian mainstream media. These BBSs also include artist-run initiatives, like Hacker Art BBS by Tommaso Tozzi, founded in 1990. In a 2018 interview with the online magazine Arshake, Tozzi explains: “Hacker Art tried to identify a new place in the computer network and its encounter with real life, a new place that enabled a collective rebellion of people to emerge” ([Pompili 2018](#b-9781474207935-012-0000256)).

## **The Public Internet—Merging Networks:** **1990–95**

The internet officially goes public in 1989, but outside of the US, in its first few years, there are barely any internet providers for the general public and artists to use. Because of this BBSs kept being the norm until about 1995, with the telephone system as the basic connecting technological network. In 1992 only ten websites yet exist. Nonetheless, word of the new networks starts to spread more widely from around 1990. The buzz around “cyberspace” and the “information highway” in advertisements, mainstream media, free media networks and academia creates a first significant peak in interest. Older and new online art communities mingle in a bigger, but still relatively small internet.

The exploration of cyberspace is not just technical. Many sense or understand the cultural effects of the internet could be tremendous and start developing novel, befitting conceptual approaches. The main artistic applications of digital network technologies in the early 1990s happen in media activism, conceptual art, performance, installation art, text-based art (hypertext, chat, email or message-based), sound art and web or browser-based art.

An example of a mainly conceptual approach in net art is VNS Matrix, an artist collective whose work still influences artists decades later. The four artists behind this Australian collective are Virginia Barratt, Julianne Pierce, Francesca da Rimini and Josephine Starrs. They are deeply inspired by theorist Donna Haraway’s *A Cyborg Manifesto*, published in 1985, in which technology is seen as a way to support the feminist cause. When only a few years later a stereotypical language and imagery surrounds the promotion of the public internet in Australia, VNS Matrix feels provoked to respond. In 1991 they write *A Cyberfeminist Manifesto for the twenty-first Century* in which they are explicit: “we are the virus of the new world order, rupturing the symbolic from within, saboteurs of big daddy mainframe, … we are the future cunt” ([Brodsky 2023](#b-9781474207935-012-0000126): 46). VNS Matrix make art installations, and spread their message through billboards, magazines and the internet, among others in the message boards and chat rooms of The Thing.

German artist Wolfgang Staehle launches the artist network The Thing in 1991, first as BBS, later moving to the web in 1995. It evolves from an online event at an art space in Cologne. In an interview with Josefina Ayerza, Staehle says he is “tired of the regular channels for disseminating information in the art world.” Since The Thing has servers in different cities in Europe as well as in New York, from the get-go it is home to a diverse community. Surveillance artist Julia Scher does text-based performances and interventions in its chat room, as does, under various pseudonyms, VNS Matrix’s Francesca da Rimini. Video artist Mariko Mori performs a Karaoke song via a video file in the first Thing online art exhibition in 1992. Artist, theorist and net activist Pit Schultz frequents its online discussions.

The 1980s generation also keeps developing new network projects. Minus Delta T (or -Δ t), one of the art groups that took part in a large Robert Adrian project on ARTEX in 1982, builds free media networks for the art exhibition Documenta in 1987 and 1992. In the 1987 edition, they broadcast a pirate TV channel from a container. For the 1992 Documenta, they go all out and organize a three-month media art performance from a container village combining BBS, satellite and television networks, and call it *Piazza Virtuale*. For this event they call themselves the European or Ponton Media Lab and Van Gogh TV (VGTV). The basic VGTV group consists of Karel Dudesek, Benjamin Heidersberger, Mike Hentz and Salvatore Vanasco. As VGTV, they create broadcasts for TV and radio networks throughout Europe. VGTV develop special software so that their international audience can participate from home in, among others, making drawings together on TV using just telephone keys as interface. The audience can also participate in discussions on the BBS message board and remotely move a camera through the VGTV containers.

The web is slowly gaining ground. From 1993 to 1994 the number of websites groes from 130 to 2,738. Still, very little art is made for the web. In 1993 the motion picture artist David Blair redevelops his *Wax, or the Discovery of Television among the Bees* to become the first film for the web. There will be no streaming until audio streaming in the mid-1990s, and video streaming starts even later. For the early online audience, the 85-minute movie is cut into 80,000 pieces connected in a hypertext structure, breaking the linearity of film. Due to the lack of internet providers the work is not accessible online until 1994, when the Institute for Advanced Technologies at the University of Virginia offers to host it.

The video and performance artist Douglas Davis creates his first work for the web in 1994, as a special addition to a survey exhibition of his oeuvre. *The World’s First Collaborative Sentence* is an open invitation to the audience to add any text to Davis’s own initial text on the site—but no fullstops, so as to create an endless sentence. The work is donated to the Whitney Museum of American Art in 1995, at a time when the Whitney does not yet have a website of its own.

Also in 1994 the US-based artist collective Critical Art Ensemble writes the influential manifesto *The Electronic Disturbance*, a call to develop new forms of protest and resistance specifically for the network society. Together with US anarchist and writer Peter Lamborn Wilson’s book *T.A.Z.: Temporary Autonomous Zone* (1991) and *The Californian Ideology* by British authors Andy Cameron and Richard Barbrook, it would inform the critical dimension of late 1990s net art discourse.

A notable thread in net art from the early 1990s is the development and interweaving of different artist generations, while simultaneously the diversity of art practices increases. The fast global spread of network practices makes it more difficult to distinguish a specific style to net art as the number of artists discovering the internet grows. The increasing number of internet providers changes the network environment: technologically, BBSs (essentially, networks on a single computer) and the internet slowly start to merge towards the mid-1990s, making the technical structure of the internet the basic infrastructure for net art from there on. We see a budding online art world, with bigger and smaller art initiatives, individual artist sites and institutional events mixed.

## **The Advance of the Worldwide Web:** **1995–2000**

Many new artists are drawn to the internet in the mid-1990s, changing art online radically. By 1995 the number of websites is 23,500, of which only very few belong to artists or art spaces. By the year 2000, the number has risen to more than 17 million, with thousands of art websites. The breakthrough of visual operating systems (from macOS to Windows and beyond) also makes working with computers and going online much easier and more attractive.

The web does not just draw more artists online, it also provokes a more widespread critical analysis of the internet’s economy and politics. Many artists and activists see the web as the shiny new shopping mall of the internet, a potential threat to anti-institutional, alternative and independent cultural practices online. Discussions about the developing internet and the role of media in art and culture become more critical. Personal computers with email software move discussions from message boards on BBSs to mailing lists, email networks in which members can send mails to all members simultaneously ([Frost 2019](#b-9781474207935-012-0000182): 78–100). Instead of messages being read on a distant server, discussions, essays, manifestos and text-based art are now received and stored on the home computer.

A mailing list that would become very important for the development of and first debates around net art was nettime. This mailing list for “net criticism” is the brainchild of Dutch theorist Geert Lovink and German artist and theorist Pit Schultz, who worry about the US influence on the development of the internet. Their idea is to develop this criticism in an open debate, in a sort of online brainstorm. This becomes nettime.

Nettime is launched at the Venice Biennial in June 1995, during a gathering of its first twenty members, including several artists and curators. It is through these artists that net art first gets its name. In early 1995 Pit Schultz curates an exhibition in Berlin called “net.art.” Serbian artist Vuk Ćosić, one of the participants, organizes a meeting of artists a few months later that produces a manifesto entitled *net.art per se*. On nettime a discussion about what the term “net.art” stands for and whether it is useful quickly follows suit. In her book *Art Criticism* *Online* art historian Charlotte Frost writes how “discussion participants … collectively refine[d] what was/is at stake when naming an art movement.”(e.g. [Frost 2019](#b-9781474207935-012-0000182): 108)

Not much later artists on nettime clash with academics, critics and activists who do not approve of artists experimenting with the email medium and its content. Some call the resulting email artworks spam or junkmail, to which artists respond by creating special spam art websites and spam tools targeting nettime. This leads to a schism in the nettime community.

In the meantime, another important mailing list for net art sees the light: Rhizome. Artist Mark Tribe founds the list in Berlin in 1996, inspired by conversations with Pit Schultz. After both Tribe and his mailing list server move to New York, Rhizome becomes an influential art institution in the new millennium. Though a few art mailing lists are launched between 1997 and 2000, for example the net.art list 7–11 (a split from nettime after moderators are installed in the latter) or the Australian Empyre, many of them are part of the nettime/Rhizome periphery, informing and creating a relatively centralized discourse around net art.

## Web Art and Other Networked Art

While quite a few artists also make art for email (code poetry, ASCII art (a sort of typewriter art) or intervention art) or use the internet in other ways, the bulk of late 1990s net art is made for the web. Because of the variety of art disciplines from which artists using the web work we see various visual languages and artistic approaches. There are two main tendencies: many use the web as independent art space with interactive features, while others explore the browser as artist material.

The most well-known example of the latter is Jodi, Dutch artist Joan Heemskerk and Belgian artist Dirk Paesmans. The duo are famous for their deconstructive approach to software elements and functions on their website jodi.org. They inspire many other artists to do the same, including artists making glitch art, a genre that emerges around 2010, in which software bugs and failures are exploited to produce art.

The artists behind Jodi relentlessly explore features of both software and hardware. Their 1996 web work *Bomb*, a commentary on a fear of terrorists using the internet hyped by mainstream media, shows a web page full of gibberish, until the “view source” option of the browser is used. Here we see a drawing of a bomb. Their work My%Desktop from 2002 is a series of recorded performances Jodi does with their 1998 CD-ROM work *OS\*\*\*\**, in which early Apple Macintosh desktop icons and features are abused to create a chaotic and overpowering audio-visual event.

The number of artists making works for the web is huge, as is illustrated by Uruguayan artist Brian Mackern’s NetArt\_Latino Database (1999–2004). Frustrated by the European and Anglo-Saxon dominance of net art discourse and the lack of attention for net art by artists from Latin America, for five years Mackern collects any web art piece by Latin American artists he can find. The majority of works never reaches audiences beyond Latin America. A book made from the project contains a 10-metre printout of the database, with one URL (web address) to nearly each line.

NetArt\_Latino Database also shows that art on the web is easily prone to decay and loss, as most works in it no longer exist. Internet providers can remove a website at will. Domain names expire or can be taken hostage after a contract expires. Some browser elements popular with artists, for example frames or the short-lived blink option, disappear in software updates, leaving works in which these are applied damaged or defunct. Also browser plug-ins often used by artists, such as Java or Flash, ultimately become compromised or no longer supported.

Even if the web is very popular among artists, other network art practices develop as well. Some works created outside the web are just as influential as those made for the browser. The possibility to reuse a digital signal for any purpose is explored in, for example, Stelarc’s *Ping Body* from 1995, in which the artist’s body receives electrical pulses depending on internet traffic. The work is named after the “ping” command that tests the round trip of a signal between computers.

Internet governance institutions are attacked and criticized in US media art activist Paul Garrin’s project Name.Space (1996–today). The work is an early top-level domain registries service, with which Garrin seeks to break the monopoly that the Internet Corporation for Assigned Names and Numbers (ICANN) has on web domain name extensions such as.com,.org,.edu,.gov and.net. A decades-long legal battle with internet governance bodies ensues.

Videoconferencing software turns out to be a great tool for artists interested in performance from about 1997 onwards. The New York art group Fakeshop creates online performances, including adaptations of science fiction movies, using a combination of softwares, including the freely available videoconferencing tool CU-SeeMe. Other artists performing this way include Dutch American artist Debra Solomon and the Slovenian artist Igor Stromajer.

Online performances using audio, which largely switch from artists using MIDI via telephone to the use of the first widespread streaming software RealAudio in 1996, remains popular for artists engaged in media activism and sound art, sometimes connecting the online signal to analogue radio stations as part of an event. The Berlin art collective Convex TV (1998) holds online events in which their web page is updated all the time, and the audience has to continuously refresh the page to have a kind of extremely slow experience of video, each web page representing a moving image frame. Meanwhile, RealAudio is used to provide the sound.

Artist activists like collective the Electronic Disturbance Theater (Ricardo Dominguez, Carmin Karasic, Brett Stalbaum and Stefan Wray), their name borrowed from the writings of the Critical Art Ensemble, use the internet as a media activist tool to organize events or to create interventions. EDT develops one of the first DDoS (distributed denial-of-service) attack softwares, a work called *Floodnet*, as part of a larger action to block several websites, among them that of the Pentagon. EDT called these blockades “virtual sit-ins.” They create considerable trouble for EDT’s web host The Thing.

Just as the politics behind internet development are criticized in Name.Space, in 1998 the socio-political dimensions of network software are explored in The Web Stalker, the first art browser, produced by the British art collective I/O/D, consisting of Matthew Fuller, Colin Green and Simon Pope. Their slogan is “Software is Mind Control—Get some.” The Web Stalker displays websites in an abstract manner, rejecting the traditional print magazine-style layout most web pages are produced in, and revealing how software predetermines how we perceive things on a computer. The Web Stalker provokes the start of a subgenre in digital art: software art.

The expanding sphere of influence of the internet and the computer in the offline world slowly but steadily becomes a subject in art. In a 1997 performance entitled *Cyberknowledge for Real People* Russian net.artist Alexei Shulgin hands out nettime newspapers to Viennese shoppers as a statement on the distance between nettime’s activists and the general public. Cameroonian artist Pascale Marthine Tayou creates an at once light-hearted and critical commentary on the utopian discourse surrounding the internet. His *Externet.com@LoooBHY* from 1999 is a pile of tech junk not unlike the e-waste dumped in the Global South. The title of the work highlights the physical reality of the new networks, where some countries are on the outside looking in, only to be left with scraps.

Just beyond the twentieth century US-based artists Mendi + Keith Obadike perform a series of Black Net.Art Actions between 2001 and 2003. In one of the first, *Blackness for Sale*, they offer their skin colour for auction on eBay. Mendi Obadike explains their actions in Rhizome’s net art anthology twenty years later: “We did not feel that the net was a colorless space, but rather, that whiteness was being set up as default” (Connor and Espenschied [2019](#b-9781474207935-012-0000132): 170).

## The New Millennium: The Dawn of the Post-Digital Age

Soon after the turn of the century the gravitational centre of net art discourse moves from Europe to the US. The European net.art scene loses momentum due to internal squabbles when the ideological and anti-institutional part of this scene, artists and critics both, declare net.art dead. Not only is the nettime community split over the net.art debates, but the mailing lists in the nettime periphery also suffer from similar internal conflicts. Despite that artists keep working with the internet and there is no significant change in their practices, the death declarations by themselves create the appearance of a major break and drop in activity. The dot-com crash in 2000 seems to aggravate the situation: for some the internet seems economically and culturally extinct after this big drop in value of NASDAQ stock. At the same time the number of internet users keeps growing and increases tenfold between 1995 and 2005. By 2005 there are over 64 million distinct websites, with numbers rising to 863 million in 2015. With such a vast expansion of users comes an inevitable fragmentation of the audience and, more importantly, a flood of both historically and technologically often less informed artists.

Illustrating the above could be Miltos Manetas and Neen, the art movement he started in 2000, specifically developed for the art market. A company called Lexicon Branding, specialized in developing new product names, creates the movement’s name for a hundred thousand dollars. For Neen, Manetas approaches several artists working with the web, among them Angelo Plessas, Rafaël Rozendaal and Nikola Tosic. His criterion is that they make single-work websites, meaning each artwork got its distinct web address. Neen is launched at the well-known New York art gallery Gagosian.

Not long after Neen’s launch, the news spreads that the Whitney Museum in New York will include net art in its 2002 biennial. Even though Neen only exists for about a year, Manetas feels excluded from the show. He suspects Neen is excluded because Neen artists use software like the, by now defunct, Flash, which is popular in commercial websites to capture audiences, rather than make works that are critical of technology. He organizes an online show with Neen artists and tells the Whitney curator they will surround the museum with trucks carrying projectors to show Neen art on its walls. The latter never happened, but the ado around his intervention creates animosity between Manetas and net artists outside Neen. The emphatic distancing of Neen from earlier net art comes across badly. Years later Manetas recalls that this incident destroyed his reputation in the net art scene (see [Moioli 2019](#b-9781474207935-012-0000234)).

The incident could be seen as a sign that the field of net art expanded so much that increasingly distinct art scenes and art discourses start to develop. Within these, two opposite tendencies can be observed. The first and major tendency is net art entering the mainstream, which also includes a trend towards commercialization. The second, smaller trend is a sort of countermovement, a continuation and refinement of existing critical media art practices, in which artists make more technological, media activist and anti-institutional works. Both develop in the context of an expanding internet and new technologies, from Web 2.0 to mobile and social media. The breakthrough of Wi-Fi early in the new millennium makes the internet appear immaterial. A move towards the “post-digital” develops, a term German theorist Florian Cramer describes as “a contemporary disenchantment with digital information systems and mediagadgets, or a period in which our fascination with these systems and gadgets has become historical” ([Cramer 2015](#b-9781474207935-012-0000146)).

## Post-Internet Art

The death declarations around net.art create the impression that all net art before the millennium was anti-institutional, political and existed entirely online among a new generation of artists exploring the internet. These often younger artists are mostly members of a US-based online community that hovers around Rhizome. What develops are a very self-conscious repositioning of artists and a next reimagining of what the internet means for art. A move away from politics and an explicit embrace of the art market ensues, with the internet as backdrop rather than environment. Californian artist Guthrie Lonergan speaks of his art as “internet aware” in a Rhizome interview in 2008 ([Beard 2008](#b-9781474207935-012-0000109)). Rhizome editor, artist and curator Marisa Olson picks up on that and coins the term “post-internet art” in an interview for the art blog WeMakeMoneyNotArt shortly after, explicitly mentioning the relation to net art. “I think it’s important to address the impacts of the internet on culture at large,” she says, “and this can be done well on networks but can and should also exist offline. Of course, it’s an exciting challenge to explain to someone how this is still internet art” ([Debatty 2008](#b-9781474207935-012-0000161)).

The engagement with network technology tends to be more superficial in post-internet art than in other net art subgenres, with a few exceptions, most notably in the work of Artie Vierkant, who translates data into physical sculpture. The reason is post-internet art’s principal focus on images, in particular those that work well online. Post-internet art is born from the “pro-surfer” (professional web surfer), or surfing clubs, shared art blogs that appeared roughly between 2006 and 2015, in which groups of artists post all kinds of images they find online. Exchanges on these blogs tend to be much more light-hearted and informal than net art discourse had been on text-heavy mailing lists, even if the latter also involved a lot of folly and play. Pro-surfer clubs partly pre-date social media such as Facebook or Instagram and provide a low threshold for artists inexperienced with technology or earlier media art to join. In this context, the line between art and non-art, and between digital and non-digital art dissolve easily.

Heavily image-oriented Web 2.0 platforms such as Flickr, YouTube, Facebook and Tumblr are launched around the same time, from 2004 to 2007 respectively, both serving and creating a new type of internet user less interested in media autonomy. Also launched in 2003, WordPress, an open-source content-management system offering easy templates to create blogs and websites, erodes the need for tech education and the development of creative web design from the other side. The arrival of the first iPhone in 2007, with its poor user interface relying almost entirely on pictures and icons for interaction, allowing for little user interference and tweaking of the miniature computer a smart phone ultimately is, further distance the internet user from the basic structure and materiality of the network. It is in this “user-friendly” environment, newly added to network technologies, that the term “post-internet art” is introduced.

## Hacker Art

In the meantime, mainly outside the US, the development of a more tech-oriented, media activist discourse around net art continues. The aforementioned rise of software art is part of a broader focus on the cultural dimensions of software, hardware and network infrastructure. There is even a reassessment of the computer virus. In 2002 the first exhibition of viruses is presented in Frankfurt, accompanied by a catalogue exploring the historical relationship between computer viruses, language, poetry and politics ([Nori 2002](#b-9781474207935-012-0000245)). The exhibition is called “I Love You,” after a computer virus that infects over ten million Windows computers in 2000.

The number of festivals, conferences and other events considering the relationship between art, network technology and politics grows, with an increased urgency to their debates after the appearance of WikiLeaks in 2006 and the revelations of Edward Snowden in 2013. A kind of critical counterpart to post-internet art develops, in which a dismissal or subversion of Web 2.0 platforms and a deconstructivist approach to hardware and network infrastructure predominates. There is no overarching term for the artists and works in this environment, although one might call it “hacker art,” art that engages with technology deeply and critically, after the EDT term “hacktivist.”

A work in this category is the 2009 *Web 2.0 Suicide Machine* by the Rotterdam-based art collective Moddr\_lab, with members Walter Langelaar, Gordan Savičić and Danja Vasiliev. The work comments on social media platform technologies making it extremely difficult to remove one’s profile forever, the most notorious being Facebook. Just when these platforms break through with a wider audience, the artists make a tool to delete oneself with one click from Facebook, Twitter, LinkedIn and Myspace. A cease and desist letter from Facebook makes attention for the project skyrocket. The *Web 2.0 Suicide Machine* makes headlines all over the world, resulting in over 80,000 Facebook users committing “virtual suicide” and over 250,000 tweets being removed from Twitter.

Soon after, two members of Moddr\_lab, Savičić and Vasiliev, move to Berlin and form a new art collective called Weise7 with Sarah Grant, Julian Oliver and Bengt Sjölen. Weise7 produce critical, mainly hardware-based net art pieces in which the artists develop alternative network infrastructures, circumventing or subverting the internet, in the shape of art installations and “networkshops.” In 2011 Oliver, Savičić and Vasiliev write *The Critical Engineering Manifesto*, in which they refine the definition of the tactical media artist ([Critical Engineering Working Group 2011](#b-9781474207935-012-0000152)).

Whereas post-internet artists and critical engineer or hacker artists make a physical move away from the internet, both have a related counterpart in art made for social media. The art of Argentinian artist Amalia Ulman and US-based artist Petra Cortright, for example, is generally labelled as post-internet art. Cortright gains fame for her YouTube video series VVEBCAM in 2007, in which she mimics the online aesthetic of thousands of vanity teen girl video diaries. Ulman’s breakthrough work, *Excellences and Perfections* from 2014, is a five-month Instagram performance in which the artist fakes a perfect dream life. Both works smoothly blend in with their environment, with Ulman creating a momentary reality check among her follower-base when she reveals her online life as performance.

In an opposite approach, Dutch artist Constant Dullaart and US-based artist Ben Grosser each develop strategies to intervene in the attention economy behind social media. Grosser creates critical software art, enabling the user to remove likes and other metrics with his *Facebook Demetricator* (2012 onwards), or to confuse the TikTok recommendation system with *Not For You* from 2020. Dullaart creates thousands of fake Facebook profiles using the names of an eighteenth-century Hessian army in his *The Possibility of an Army* in 2015. Using the hired services of Chinese fake follower farms, the “army” is to invade and distort the Facebook newsfeed algorithm with their fake profile activities.

In general, net art after the year 2000 develops both on- and offline, around a network infrastructure in which Wi-Fi and apps obscure the role of internet infrastructure.

## Conclusion

Net art is a field of art in which cultural, technological, political and economic aspects of digital computer networks, in particular the internet, form the basis or backdrop for a work of art. The internet should be understood as an assemblage of networks that evolved over time, with smaller networks connecting to or retracting from a basic internet infrastructure. Different technologies developed around and for the internet influence or inform the shape of art made in this context, depending on the respective art practice and discipline of the individual artist or art collective. From computer timesharing to the web to social media and beyond, artists explore and use whatever aspects of network technology and its applications they find or need, including its weaknesses.

The most important tendencies in net art are the formation of online artist-run initiatives and other experimental art spaces (from media labs to online galleries), a rise in international collaborative projects often including audience participation and an increase of artists making media art or art for media, with a varying level of political or technical engagement. With the use of technology now reaching across different art fields, net art bridges the twentieth-century, pre-internet divide between media art and contemporary art.

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“Code art” goes back to the 1960s at a time when access to the few computers in the world was open only to the engineers, scientists and researchers who worked at the corporations and universities who had purchased these massive, expensive machines. However, the idea of “code art” can be extended beyond the time that artists had access to computers. The *ideas* that are explored with the first art created using computers go back decades before.

The relationship between art and code doesn’t require computers. “Code art” is defined as a set of instructions that define an artwork. These instructions can be source code that runs on a computing machine, but they can be run in different ways, for example by other types of machines or read and performed by people. A comparison to music helps to clarify this distinction. Computer code is analogous to a music score. A score is a technical document that isn’t the artwork: it’s the specification of the performance. Further, a score is a precise notation that is learned by a composer, often through years of study and practice. The “code” in a work of “code art” is also not the artwork: it’s the set of instructions that specify the boundaries and performance of the artwork. Like sheet music, the language of code isn’t something the general public understands, but it’s a precise language that defines the performance of the artwork.

Other entries in the *Encyclopedia of New Media Art* will provide related perspectives into the topic of code art, including entries on net art, art on the web, Jack Burnham, software studies, art and technology, new media art, media art and networked art. This specific article focuses on a small number of artists and artworks that are representational of the larger field. Long lists of artists aren’t included here—code art is international and spans decades so any list of names intending to represent the entirety of the endeavour will be incomplete and inaccurate.

## Code Art Before Computers

As far back as 1923, the visual arts pioneer László Moholy-Nagy explored painting as a set of instructions that were independent from the material artwork. His artworks *EM 1*, *EM 2* and *EM 3* are the same composition in different sizes. These are known as the “telephone pictures” because they were fabricated at an enamel factory according to instructions that were given over the telephone. Like art made with computer code, the instructions for the images were detailed and specified before the artwork was produced. Today, an artist might code these instructions themself and render a digital file with code to be fabricated, but the process is essentially the same.

Sol LeWitt is another artist who pioneered separating the artwork’s instructions from creating the physical artwork. His wall drawings began in 1968 as a way to move drawings from paper or canvas and back into architectural space as it had once been with frescos. The distinguishing element of a wall drawing is the short set of instructions that define the drawing written in English. When these artworks are collected, the instructions are exchanged and not the rendering of the artwork on the wall. In fact, the drawing itself isn’t the complete artwork as it would be with a specific painting. A wall can be drawn and redrawn many times, the definition of the artwork is separate from the rendering and there’s no original drawing. Furthermore, each time the drawing is made, it can be different. There’s always room for interpretation in the instructions and the draftsperson can make these decisions autonomously. Another important point is that LeWitt himself doesn’t need to be the draftsperson—the artist’s hand is separated from the final visual images as well.

The idea of the artist incorporating variability within an artwork is discussed eloquently in Umberto Eco’s book *The Open Work*, originally published in Italian in 1962. He described the concept of an artwork as defined as structural relationships between elements that can be modulated to make a series of distinct works. John Cage, Alexander Calder and Yaacov Agam are examples of artists working in this manner contemporary to Eco’s text. While all artworks are interpreted by the individual, he distinguished the interpretation involved in this approach to making art as fundamentally different from the interpretation of a musician playing from a score or a person looking at a painting. An open work presents a *field of possibilities* where the material form as well as the semantic content is open. Eco’s ideas apply equally to music, sculpture and visual art, but in hindsight, they clearly align with artists who work with code as well.

In the text that follows, the fundamental ideas represented through Moholy-Nagy, LeWitt and Eco will play out in visual artworks created by artists who work with code.

## Code and Drawing

Throughout the 1960s and continuing today, artists are working with plotters to create drawings from code. Plotters were first created by industry to automate precise technical drawings, but were soon co-opted by artists in order to explore new ways of creating drawings. They range from a two-ton ZUSE Graphomat Z64 from the 1960s to a four-feet-tall HP 7580 from the 1980s to an AxiDraw from the 2000s, which is compact enough to fit nicely on a small table. These drawings are a way to translate code into material form using a wide range of papers and pigments.

Michael Noll’s memorandum “Patterns by 7090” is an early and fascinating document in the history of code and images. This short text, distributed internally at Bell Telephone Laboratories (Bell Labs) on August 28, 1962, outlines Noll’s first attempts at creating “patterns” by rendering images into microfilm. He used an IBM 7090 computer and the Stromberg-Carlson 4020 Microfilm Recorder to create eight patterns. Each image was programmed in the FORTRAN language and the code and image for each are reproduced in the text as well as a description of each. Noll is careful about claiming the images as artwork; he wrote, “Rather than risk an unintentional debate at this time on whether the computer-produced designs are truly art or not, the results of the machine’s endeavors will simply be called ‘Patterns’” ([Noll 1962](#b-9781474207935-013-0000160)). Regardless of the designation of “art” or not from their creator, these are remarkable early images created with code.

In the 1960s, the endeavour of creating drawings with code was incredibly different from today. A German television crew filmed Frieder Nake at the University of Stuttgart in 1965 as he was creating some of his now iconic computer drawings. In the film, we see Nake sitting at a desk making diagrams on paper. At this point in the creative process, he’s not writing code, he’s figuring out the logic of the visual system. The film skips the step of Nake’s program being input into the SEL ER56 computer, but we do see the output, a thin paper tape filled with a pattern of holes. This paper tape is inserted into another machine, a massive ZUSE Graphomat Z64. Even at this point, Nake still didn’t know what the drawings would look like. As the paper tape moves through the drawing machine, the encoded instructions control a series of motors to move a pen across a piece of paper. Now with the drawing rendered, the artists can finally connect their original ideas with a physical drawing.

In 1965, the first plotter drawings were shown in exhibitions at the Howard Wise Gallery in New York and Galerie Wendelin Niedlich in Stuttgart. These exhibitions had little international impact at the time, but they marked the beginning of computer-generated work shown within an art context. At this moment in time, very few people had access to computers. Computers were expensive machines that existed in research laboratories and universities and their use was limited to people within those locations. The introduction of computer-created art to the world stage happened a few years later in 1968. The “Cybernetic Serendipity” exhibition at the Institute of Contemporary Arts (ICA) in London was a breakthrough exhibition that presented the state of the art to the public. As curated by Jasia Reichardt, this exhibition remains unique to this day in the way that it presented the work of artists next to the work of scientists. It combined images, sound, film and sculpture together into a massive exhibition. In addition to displaying early plotter drawings, it also exhibited analogue oscilloscope circuit drawings by Ben Laposky going back to the 1950s as well as other older analogue drawing machines.

After a moment of institutional enthusiasm for art and technology initiatives in the late 1960s and early 1970s, support waned. The “Cybernetic Serendipity” exhibition as well as the “Software” exhibition in New York curated by Jack Burnham and the Nine Evenings performances produced by the Experiments in Art and Technology (E.A.T.) group in New York were not well received by the broader public and art critics. Between the public opinion of these exhibitions and general rising anti-technology sentiments led by public protests of the Vietnam War at the time, enthusiasm around the synthesis of art and technology waned.

However, new artists found their way into the area in the following years and the exploration continued. Manfred Mohr and Vera Molnár, both working in France at the time, are among the first trained artists to start working with computers and plotters. Molnár had been creating artwork for two decades before using computers to augment her work. Throughout the 1960s, Molnár was working with combinatorial images and, in 1968, she started working with code to automate the combinations. She engaged with finding form through automation that wouldn’t be found any other way. She once wrote, “I use the computer to combine forms, hoping that this tool will enable me to distance myself from what I have learned” ([Molnár 1990](#b-9781474207935-013-0000154): 16). Molnár was able to access computers through the Université de Paris I, Sorbonne in Orsay and Manfred Mohr did so through the Computing Centre at Météorologie Nationale in Paris, at a time when artists had to write their own programs because no written software existed. In the 1960s, Mohr was influenced by the writings of Professor Max Bense, a German philosopher who wrote about generative aesthetics. Manfred Mohr’s “Une Esthétique Programmée” exhibition in 1971 at ARC, Musée d’Art Moderne de la Ville de Paris was the first solo exhibition of code-generated work within a museum.

Across the globe in California, Harold Cohen was exploring a different way of drawing with code. Cohen’s work is distinguished by its early use of artificial intelligence to create drawings through his AARON software. Cohen was an established British painter when he wrote his first computer program in 1968. One year later, he became a full-time art professor at the University of California, San Diego where he spent decades working on AARON. The AARON software was created to generate drawings according to the rules that Cohen encoded. Every time AARON ran, it created an expected drawing in the manner defined by the code. Early versions of AARON had an understanding of line intersection and shapes and drew shapes reminiscent of rocks. Later in the 1980s, Cohen developed AARON to draw plant forms and then people. AARON continued to develop to learn colour theory and, later, newer sorts of abstracted form.

Artists working with code to create drawings was an international phenomenon with artists often working independently, only learning about each other’s work later at conferences and professional gatherings. The list of artists who committed to writing code and working with plotters through the 1970s and 1980s and beyond is long. In the time before the public internet, the larger community awareness of work happened more slowly and sometimes it didn’t happen at all. As one example, the ART1 coding system developed by Professor Richard Williams at the University of New Mexico and used by art professor Katherine Nash to explore the computer for drawing. ART1 is documented briefly in Jasia Reichardt’s *The Computer in Art* book from 1971, but its history wasn’t fully documented until Patrick Frank’s book *Sharing Code* was released in 2020.

## Code and Animation

Almost as early as people starting to create drawings with plotters, they started to create films with computer graphics. As with other forms of computer graphics at the beginning, Bell Labs was a site for the production of early computer films. The first computer film at Bell Labs was E. E. Zajac’s animated diagram of a satellite orbiting around the earth from 1963.

From 1964 to 1970, artist Stan VanDerBeek worked with Bell Labs researcher Ken Knowlton on a series of *Poemfield* films. These 16 mm films were created with the TARPS, a coding language derived from BEFLIX, both developed by Knowlton. VanDerBeek came to Bell Labs as an artist in residence with a background in experimental animation and video. Each film in the series combines text and visual patterns created from a grid of alphanumeric characters to produce a hybrid experience of poetry, image and animation. VanDerBeek remarked on the process, “the artist is no longer restricted to the exact execution of the form; so long as he is clear in his mind as to what he wants, eventually he can realize his movie” (quoted in [Mancia and Van Dyke 1970](#b-9781474207935-013-0000149): 70).

The extraordinary early films of artist Lillian Schwartz were created at Bell Labs as well. For her first films created with code, Schwartz would edit the films tightly to an existing piece of music and she created a collage of different types of media. For example, for *Mutations*, created in 1972, she used synthesized audio composed by Jean-Claude Risset. The film combines footage of crystal growth and reflected lasers along with the rendered computer images into an energetic audio-visual experience. In seeking new visual possibilities defined by Schwartz, Ken Knowlton developed the EXPLOR code to break away from the visual symbols used within the *Poemfields* to allow for the new possibilities of randomization and permutation.

On the West Coast of the United States, John Whitney and his brother James Whitney had been making experimental abstract films since the 1940s. Some of these films were created with custom analogue machines that John had modified, and the work at that time explored the relation between image and sound. From this experience of “programming” physical machines, John Whitney later moved into creating experimental films to explore image–sound relationships with digital computers. He collaborated with Jack Citron of IBM to create the colour 16 mm film *Permutations*, released in 1967. Citron wrote the GRAF (Graphic Additions to FORTRAN) code that Whitney used to create the film.

The works of VanDerBeek, Schwartz and Whitney are only a few of many early films created with code. More early collaborations in code-based computer animation are documented in *Expanded Cinema*, written by Gene Youngblood and published in 1970. The Bell Labs work is explained in great detail in Zabet Patterson’s *Peripheral Vision*, published in 2015.

As time progressed, films created with code became more common, but their nature also changed. Instead of an artist writing code to produce the films directly, often a team would create custom animation software that could be used by non-coders. With this, computer graphics started to be used more within television advertisements and Hollywood-style films. In the wider view of international activity, the annual SIGGRAPH conference became the primary place to show films created with code and computer graphics. In this timeline, things get a little muddled between categorizing animation created with code in contrast to animation created with custom-coded animation software. Also, it can be difficult to compare the scale of projects created by a single artist versus a large collaborative team in industry.

The 1982 film *Tron* is the first film with major scenes composed entirely of computer graphics, and it was only possible through multiple animation studios with multidisciplinary teams of artists and programmers working at maximum capacity to create the frames. Custom software and animation techniques were required to imagine and realize the action of the film taking place within the circuits of a computer. Animation studios often come from software and coding backgrounds. The Pixar animation studio, now a part of Disney, started as a software development company. Prior to becoming a movie studio, Pixar developed the RenderMan software. The first short films produced by Pixar used its custom tools, created with their own custom code. So is that “code art”? It’s not an easy distinction to make, but films of this nature weren’t created entirely with code—they were made with a range of tools.

Like with plotter drawings created with code, individual artists have continued to create animation with code since the origins in the 1960s. An overlap remains between artists working to create special effects for industry and making their own work. As animation software has become more powerful with tools like Maya, Cinema 4D and Blender, it’s more common to see artists coding within those environments, rather than writing code from scratch. Today, rather than working with film or video, many artists write code to create real-time software animation that is exhibited in galleries or as live code running in a web browser.

## Code and Hypermedia

After decades of artists needing to work in research labs to have access to writing code, new kinds of computers allowed artists to work with software in their studios. The idea of a “home computer” grew out of experimentation and lower-cost computer chips where the ratio of computer power to cost was a delicate balance. Computers like the Altair 8800 announced in 1975 were too limited to be practically used by artists but they were essential for popularizing the idea. The next generations of machines opened up new opportunities such as the Apple II in 1977, the Apple Macintosh in 1984 and the Commodore Amiga in 1985. In addition to home computers, new kinds of home electronics were created at this time and aggressively marketed as the future of entertainment.

LaserDisc machines were first introduced in 1978 to bring higher-quality video into homes. Because they were optical discs and not tape media like VHS and Betamax video they could play video stored on the disk in any order, so video could be controlled through code. One prominent example is the arcade video game *Dragon’s Lair*, which used LaserDisc media to store and play back sequences of animation depending on the choices of the player within the game.

Artist Lynn Hershman Leeson created an early and pioneering project with her LaserDisc artwork *Lorna*, produced in a limited release in 1983. Through a television remote control, the viewer makes decisions about the actions of Lorna, the main character for the artwork. In Hershman’s words Lorna is, “an agoraphobic woman who lives in fear of the outside world. Fear is generated by ingesting media that she sees via her remote unit on her TV set, which shows wars and pervasive advertising through which she is manipulated” (Reas and Fry 2014: 249). The viewer makes a series of choices for Lorna that affect the ending. She can either shoot her television, commit suicide or move to Los Angeles, the worst ending according to Hershman. *Lorna* is a unique artwork from this time, and although more artists didn’t adopt the technology then, it pointed the way to the CD-ROM era of art media, discussed more below.

The Macintosh was significant as the first successful home computer launch with a graphical user interface using the WIMP (windows, icons, menus, pointer) model pioneered at the Xerox PARC research lab. Prior to the Macintosh, home computers were “command-line” computers that were controlled by keyboard commands. The Macintosh arrived with the extraordinary MacPaint software written by Bill Atkinson. This computer was only capable of displaying black-and-white pixels and had a small screen, but MacPaint was the first home version of a digital painting program. This program was the foundation for much of what was to come after with its menu bar of icons for different software drawing tools like a digital pencil, paint brush and spray can.

In response to watching his young child use MacPaint, Craig Hickman wrote a new drawing program called *Kid Pix*. *Kid Pix* is a software utility that is a work of code art. It’s inventive and playful in ways that other software from the era was not. It’s a predecessor to other artist-created drawing tools like Jürg Lehni’s *Scriptographer* and Adrian Ward’s satirical *Auto-Illustrator*. Unlike other drawing software written to date, Hickman invented new ways of drawing that are unique to software and don’t rely on direct metaphors to physical drawing tools. The “moving truck” tool allows the person drawing to copy sections of pixel from one location to another. The “dynamite” tool explodes the drawing with a flash of circles to dynamically erase the canvas. The first version of *Kid Pix* was released in 1989 and was later acquired and further developed by the software publisher Broderbund.

The Macintosh was a fertile platform for other development tools to allow artists to work with code. The HyperCard software, created by MacPaint creator Bill Atkinson, was the first program of its kind. Most importantly, it had a built-in scripting language called HyperTalk and an interface that allowed artists to create their own software without needing to write everything from scratch. HyperCard was a multimedia environment; it was used to combine images, interface elements and code together into custom applications. Because HyperCard came installed on the Macintosh computers, it was used widely for all kinds of purposes such as creating homemade games and other hobby applications. It was also used by artists to explore the possibilities of new forms of experimental interactive media.

A HyperCard program is called a “stack” because the mental model is a series of “cards” (screens) that make up the software. The person viewing the stack can link from card to card in a non-linear way. The idea of linking a piece of text or image to another document existed long before the HyperCard software as the idea of a “hyperlink” and “hypertext” system. We’re now familiar with this way of linking from one document to another as the foundation of the web, but HyperCard was an early interpretation of these ideas before the web.

*Dreamtime* by Stuart Moulthrop from 1992 is one example among many artworks created with HyperCard. As a writer, Moulthrop created *Dreamtime* as a “multimedia hypertext” that combines text, image and navigation elements into a space of active looking and reading. It’s a non-linear experience of reading text and navigating the environment. *Dreamtime* starts with what appears to be five cards: SPIRE, KINDLE, ARK, TRANS and FLEX. The choice of selecting one of these introduces new text and image elements. The viewer can wind a path through the possibilities.

The next stage in multimedia creation tools was bolstered by the Director software and a surge in the creation and consumption of CD-ROMs. In the era before the popularity of the World Wide Web and after home computers became more ubiquitous and powerful, CD-ROMs were a way of distributing media-rich software such as games, audio-visual educational experiences and more. It was common at the time to visit a toy store or computer store and see shelves of packaged software like *Myst*, an exploration and puzzle game.

The Director software has a long history of development and it had a quick death. It started as VideoWorks in 1985 and the name was changed to Macromedia Director in 1993. In the 1990s it became the software that introduced a generation of artists and designers to coding. It was later purchased by Adobe in 2008 and then was terminated in 2017. Director was the primary authoring tool to create CD-ROMs and was later used to publish audio-visual work to the World Wide Web. The Director interface is similar to HyperCard in the way it allows code to be applied directly to media elements, but Director also operates with a “score” interface that is a linear timeline for animation. The Lingo scripting language was developed for the software by John Henry Thompson. Over the years, Lingo was extended to become more and more capable for artists to expand what the Director software could do. Because CD-ROMs were commercial projects released by publishers as packaged software, they required budgets that were different from what an experimental or unknown artist could produce alone. As a result, many of the art-oriented CD-ROMs were created by crossover artists like Peter Gabriel and Laurie Anderson.

The *Puppet Motel* CD-ROM by Laurie Anderson and Hsin-Chien Huang is an example of the emerging media at the time. The Director software, like HyperCard, was built around displaying and assigning code to media elements. At the time *Puppet Motel* was released in 1995, short video clips and animations could be combined with other audio and images. The experience of navigating through *Puppet Motel* is an active exploration. From scene to scene, the viewer has the opportunity to make decisions, to play Anderson’s specialized violins, and to uncover unexpected images and sound. Anderson’s music is the backbone of a visual experience and the sound is accompanied by surreal spaces composed of photographs, 3D renderings, and animation. Within the technical constraints of the time, *Puppet Motel* manages to feel immersive; it’s an artistic and technical achievement.

## Code and Simulation

Through the 1990s, artists continued to work with the latest computing technology inside of institutions and technology facilities. The rapidly developing science around artificial life at this time focused the attention of artists and led to highly original work that is unique to art and code. Some artists who pursued artificial life simulation at that time wrote their own code and others collaborated with others with great technical expertise. Because computer code naturally defines actions and processes to be performed, it is a unique medium for exploring ideas of growth and evolutions within the visual arts. The 2004 book *Metacreation: Art and Artificial Life* written by Mitchell Whitelaw follows the story of many other artists who explored natural systems and simulation in addition to the two projects mentioned below.

While working as an artist in residence at Thinking Machines, the creator of the Connection Machine parallel supercomputer, Karl Sims, created *Evolved Virtual Creatures* in 1994 as an environment for evolving virtual organisms by using competition as the fitness measure. In the video documentation of the project, we see organisms composed of rectangular solids performing different tasks. They look like simple blocks, but they move in a fluid and natural way. Although visually interesting, the most appealing aspect of this work is not the animation, but the fascinating behaviours and methods of locomotion that develop through the simulated evolutionary process. In this simulated world, the organisms competed at tasks like swimming the fastest or facing off against one another to capture a green block. Each organism in the simulation was made up of a number of jointed blocks, sensors and a minimal brain. Each creature’s behaviour was determined by a virtual brain that accepted input sensor values and provided output values for the actuators. The organisms experienced their simulated world through the values of their joint sensors, a primitive visual system (which can detect orientation, the position of the ball and the centre of mass of the opponent) and contact sensors on the face of each part of their bodies. The way an organism moved was dependent on its size, shape and morphology. These were determined by its genetic representation—a directed graph of nodes and connections. New organisms were created by mutating and merging these graphs.

The collaboration between artist William Latham and programmer Stephen Todd provides another example of pursuing biological simulation as a medium in the 1980s and 1990s. With a focus on generating 3D form, they created “ghosts of sculptures.” Latham’s evolutionary FormSynth drawings that pre-date the collaboration show the idea of mutating and combining 3D form to create unexpected shapes. For example, a cone could have an adaptation of a “beak” or a “bulge.” One of these forms could combine with a mutated cube to produce something with traits of both. With Todd, they created the Mutator software to follow a similar process, to allow them to select and “breed” computational geometry through an interface of their own design. Their book *Evolutionary Art and Computers* defines this work in depth. In addition to high-resolution photographic prints, they produced *Mutations* in 1991, a three-minute film showing a textured 3D form in motion. The film’s opening titles sequence states that it is “An art film produced using ‘Darwinian’ evolution with artist controlled aesthetic selection.”

## Code and Generativity

Before going deeper into the realm of generative art, a clear definition sets the stage for the discussion. The definition provided by Philip Galanter in 2003 is a starting point that covers a wide range of approaches:

Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art.

The ideas of generative art created with code go back to the origins in the 1960s and there are many examples of artists producing systematic generative work without computers.

The era of early home computers in the 1980s is also a moment of discovery for artists (and non-artists) working with real-time, generative animation. The Commodore 64 User’s Guide published for that computer in 1982 includes a three-line program for producing random graphics on page 53. This program flips a virtual coin over and over to fill the screen with forward or backward diagonal lines into a continuous random pattern. The potential of small programs like this led artist Samia Halaby to bring a Commodore Amiga computer into her studio. Halaby was an experienced painter, but she wanted to explore a new medium, one that she felt was emerging at this moment in time. In a video filmed in Halaby’s studio in 2018, she takes the cover off the 33-year-old computer and she discusses the code she wrote at the time for creating random colour and timers to control the choreography of her generative graphics and audio. Her work from that time is vibrant and sophisticated and only the low-resolution of the screen display separates it from contemporary work.

In the 1990s, more artists were creating real-time generative art as a part of installation at museums and galleries around the globe. As one example, the “Mediascape” exhibition at the Guggenheim Museum in Soho in 1996 featured a number of interactive software artworks including Jeffrey Shaw’s *Legible City*, Bill Seaman’s *Passage Sets/One Pulls Pivots at the Tip of the Tongue* and Toshio Iwai’s *Piano—As Image Media*. Iwai’s installation mixes projected graphics, a physical interface for the audience and a robotic grand piano into a seamless sculpture. A grid projected in front of the piano keys shows small rectangles as the viewer draws them into the space. There is one column for each white key on the piano and the rectangles move towards the keys until they touch the key and a connected motor plays the physical key in the gallery. A second projection converts the sound into a colourful visual display that moves upwards in the space. Here, software and hardware are overlaid without friction to create a space of new possibility in a mundane gallery space.

John Maeda’s collection of four Reactive Books is another unique set of artworks from this time. Since the mid-1990s Maeda has been exploring computation as an expressive medium through the synthesis of the humanist values of design with the skills of an engineer. The first artwork from this series, *The Reactive Square*, was inspired by the geometric work of Kazimir Malevich and Maeda’s desire to create an alternative way for his children to interact with his computer. This work is made up of eight identical black static squares, each with its own responsive behaviour that reveals itself when someone speaks to it. Each square reacts to sound and in relation to its behaviour so that speech is transformed into a kinetic image. The software was included on a floppy disk within the book. The other works in the series explore other interfaces: keyboard, clock and camera.

It took until the 2000s until the speed and cost of computers made some forms of generative art more widespread. As the 1990s were ending, the accessibility of computers capable of running real-time graphics increased as PCs with graphical processing units (GPUs) became more affordable. Much of the artwork created with code through the 1990s including virtual reality installations required the use of Silicon Graphics computers or machines that were hundreds of thousands of dollars at the time. These new GPUs made working with generative code more accessible. International conferences, events and websites like Generator.x and runme.org further spread the word.

The release of touchscreen devices like the first Apple iPhone in 2007 and iPad in 2010 opened new opportunities for code art because of the integrated touch interface and the range of sensors including the built-in camera. Some artists rushed to release apps for this new category of devices when the App Store was released. Artists created new work and also ported older work to benefit from a new form of distribution. There’s an overwhelming number of artist-created apps for Apple and Google devices at this point, but to focus on only a few. For example, Brian Eno released *Bloom*, in 2008, a minimal but effective audio experience that works extremely well with the touchscreen. In this app, each finger touch triggers a tone that plays in a loop. Each tone is visualized as a growing circle, similar to a ripple when a stone hits still water. Jeffrey Scudder has created a set of unique drawing programs for Apple touch devices starting with *Shrub* (2014) and *Finger Quilt* (2016) and the expansive *No Paint* (2016/20). *No Paint* is created in the tradition of automated drawings. It has a library of active software brushes that draw automatically to the screen. The most essential action from the user is to select “Paint” to freeze the most recent gesture to the screen or “No” to remove it. As defined directly in the app, “Press Paint if you like what you see and No if you don’t.” This simple mechanism creates an interesting tension over control of the drawing. Looking deeper, *No Paint* has a text interface for selecting brushes and a “playlist” feature that makes it possible to script a sequence of different brushes.

Apple’s strict policies to control the platform created an unfriendly environment for artists who work with political topics. In one case, Josh Begley was blocked from releasing an app that sent a push notification every time the United States made a drone strike in Pakistan, Yemen or Somalia. Apple rejected the app as “crude and objectionable,” but the larger issue is they have the power to centrally control distribution. The strict policies of the App Store, the cost of maintaining a developer’s licence and the other complexities of releasing artwork within the software ecology led to the initial excitement fading over time.

## Code on the Network

The surge in global accessibility of the World Wide Web in the 1990s was a catalyst for new energy around art and code. Artists working with code were one of many communities that established themselves in new ways through the emerging World Wide Web. Using web technology, an artist could publish their work online and anyone in the world with a network connection could experience it. This allowed artists to self-publish their work globally without the need for intermediary art institutions like galleries and museums. The “view source” functionality built into web browsers made the code behind a web page open and could be viewed by everyone. Because web technologies were created for text documents, artists making generative images with code couldn’t create their work directly in the web browser. New software was developed and adapted to display this kind of work online.

The Shockwave plug-in was developed in 1995 to allow Macromedia Director programs to run within the Netscape web browser. This software technology bridged the gap between the CD-ROM landscape and the new audiences created by the web. However, computer network connections were extremely slow in the mid-1990s compared to now so the kinds of media running in the Shockwave plug-in were limited compared to what could be distributed on an optical disk like a CD-ROM. Unlike a web page, which was created to display text with links, tables and static images, the Shockwave plug-in supported sound, animation and custom typography. Because of the slow speed of internet connections at the time, new forms of media started to dominate code-based work in the browser. Macromedia further developed their Flash animation environment to include a scripting language called ActionScript. In the late 1990s and early 2000s, Java Applets were another popular way that artists created work in the browser.

Between these three platforms and others, a massive collection of artists, designers, coders and hybrids of all three started to publish their artwork in the browser rather than through galleries or other institutions. To select a few for discussion, Lia launched Re-move (re-move.org) in 1999 as a series of ten interactive Shockwave programs coded with Lingo. Like her earlier work on Turux, these are dynamic, “semi-automatic” pixel painting systems that draw to the screen and allow the viewer to modify the way they draw. Unlike other drawing systems, the artwork on *Re-move* autonomously fills the space with its unique gestures and marks. A line of cryptic symbols on the bottom of the drawing area allows the viewer to make changes within a set of constraints. John F. Simon Jr.’s online artwork *Every Icon* is a different approach to online generative art. This work is a stark grid of 32 × 32 elements, the same resolution as the original icons for the Macintosh computer. The premise of *Every Icon* is to turn on and off every pixel in sequence to eventually produce every possible computer icon. Starting in the upper-left corner, each pixel is turned on and off in sequential order. Simon calculated that it would take sixteen months to move through all of the possibilities of the first line alone and the complete process would take “several hundred trillion years.” What is seen in *Every Icon* is a sequence of rectangles flashing on and off, but the idea of the artwork is an interesting provocation about the possibilities that exist within even such a minimal system of digital art.

It was common for code artists to openly share their source code in the early 2000s. Within the community of artists writing code with Flash, Joshua Davis was a strong advocate of sharing example code and many followed. The Processing programming language and environment for artists included the source code by default when the software was exported for the web as Java Applets. Jared Tarbell’s website Complexification (complexification.net) was a source of inspiration for artists working with Processing code and he shared all the source code online. Through these artists and hundreds more sharing code online and in community bulletin boards, the community learned together. Writing code is a form of craftwork that enables artists to express their ideas, and the community at that time actively supported new artists in learning this craft.

Following a decade of change with web technologies like Flash, Shockwave and Applets in relation to web browsers, the artwork is no longer visible. A viewer of websites from that era is confronted with an empty space where the media used to be and the text “Adobe Flash Player is no longer supported” or “This plug-in is not supported.” The artworks from this time are a casualty of corporate software wars and the fact that the artwork was created with proprietary, close-source software. After Adobe bought Director from Macromedia, they discontinued it in 2017 and Apple discontinued supporting Flash on iOS, its mobile operating system. Organizations like Rhizome and the Internet Archive are doing work to emulate this media. As one example, Rhizome released an online emulation of Lia’s re-move.org as a part of their Net Art Anthology project.

The web was a vibrant area of new activity for artists in the mid-1990s and that energy changed as corporations and commerce moved into the web space and fuelled the so-called dot-com boom and bust at the turn of the century. This early art and internet work has now been archived and published, but the energy of experimentation largely disappeared until the widespread adoption of NFTs in 2021. This enthusiasm was extremely different because of the way NFTs are tied to collecting and cryptocurrency. One of the primary ideals of early art on the internet was its existence outside of art market dynamics and institutions. NFTs were also outside of traditional art market dynamics at the start, but they have always been tied to collecting. Two things about NFTs are clear at this point: they are divisive within communities of artists in relation to their energy use and they have brought a new public awareness to artists working with code.

When the Art Blocks platform launched in November 2021, it introduced a new idea for generative art. Artists have pursued generative art for decades, but Art Blocks created something new by storing the code that creates the artwork directly within the Ethereum blockchain. For people who believe the Ethereum blockchain will exist “forever,” this creates the promise that the fundamental component of generative art, the code, will be accessible into the future and also the record of ownership will be noted within the same blockchain. The first project on Art Blocks was *Chromie Squiggle* by Snofro (founder Erick Calderon). Because each of the planned 10,000 artworks in the edition is generated with code and each has a different random number seed, the code read from the blockchain produces a different result for each iteration of the total edition. When an Art Blocks work is seen in the browser, it’s running at that moment as live code. Over the first year, over 200 projects were launched on Art Blocks and the space of on-chain generative art has grown and new platforms and galleries are continuing to launch.

## Code Itself

What does code look like and how is it used to make visual images? Code is traditionally used in computer science curriculums to write programs to tell computers what to do, and code originated in the sciences and engineering fields to instruct a computer how to calculate a specific set of numbers. These are different goals than an artist might have with code. For artists to work with code, different kinds of coding languages were invented and extensions to existing programming languages were created to place the focus on creating images. People working with sound (composers) and text (writers) have also used code for decades to enable new kinds of work, but here the focus is more on the visual arts.

Many programming languages have been designed for visual artists and designers and while these languages have integrated the vocabulary of the arts, they impose many constraints which are inappropriate for the thought processes and methodologies of visually oriented people. Like their predecessors, these languages are strict and do not support ambiguity, intuition or a fluid working methodology. They impose their own constraints on minds that prefer to function in other ways and they require strict written expression, rather than supporting visual nuance. Programming does not need to be this way. Visual artists and designers have the opportunity to write new languages for defining computation in hybrid visual and text structures which build on humans’ inherent visual perception skills. These languages can be written on top of existing high-level languages (e.g. Java or C) the same way that the high-level languages are written on top of assembly language. There is enormous potential waiting to be released and the development of new languages will radically shift the kinds of software that are written and who is writing it.

A few decades ago, computers behaved very differently than today. When a computer was turned on, a black screen appeared, and a blinking white cursor was displayed in the corner. The machine didn’t do anything until it was told to do something. To program the computer, lines of code could be typed directly:

10 HGR

20 LET X = RND (1) \* 279

30 LET Y = RND (1) \* 191

40 HCOLOR = 1

50 HPLOT 80,90 TO X,Y

60 LET F = F+1

70 IF F > 100 THEN GOTO 90

80 GOTO 20

90 END

This is a programming language called BASIC. To see what the program does, a person would type “run,” followed by pressing the Return key. Contemporary computers can do many things that were not possible in the past—they display high-resolution images, connect to the web and process complex data in real time—but programming languages have changed very little. A program is an exact set of instructions which tells the computer precisely what to do. It is a sequence of formatted words and symbols that encodes ideas into a structure which can be interpreted by a machine. Each programming language is a collection of words and symbols (syntax) with a set of rules defining their use (semantics). Each language allows people to encode their ideas in different ways. In Processing, a language based on the Java programming language, a program to produce a similar result to the BASIC code above could be written like this:

size(279, 191);

int f = 0;

while (f < 100) {

float x = random(279);

float y = random(191);

line(80, 90, x, y);

f = f + 1;

}

The first computer languages were developed with the origin of electronic digital computers in the mid-twentieth century. These languages were commands encoded as zeros and ones and their structure was closely aligned with the hardware of the machine. Because each computer was designed differently, they all had unique languages tailored for their physical specifications. Each type of modern microprocessor also has its own native language. These fundamental languages are called machine code and they have a direct correspondence to easier-to-read assembly languages. For example, Intel 8080 processors have an assembly language which looks like this:

ORG 0100h

LXI DE, Text

MVI C,9

CALL 5

RET

Text: DB ‘Hello!$’

END

It is more difficult to write programs in assembly languages than with high-level languages like BASIC and Processing (shown above), but when this program is translated into executable machine code, the result is even more difficult for people to understand:

11 09 01 0E 09 CD 05 00 C9 48 65 6C 6C 6F 21 24

It is clear that machine languages are very different from human languages: they are terse, have strict syntactical rules and small vocabularies. In contrast, our human languages are verbose, ambiguous and contain large vocabularies. Many programming languages are compromises between the types of languages people are naturally comfortable using and the kinds of languages machines require for interpreting our intentions.

Through the history of artists writing code, they have at times used low-level languages (especially in the early days) and they have also created their own high-level ways of writing code themselves or in collaboration with others. The programming languages and environments that artists use today are less focused on efficiency than at one time because computers are much faster. There are more languages to create code art with than ever before that allow artists to make applications and apps, and to run code within a web browser. Artists write code directly as text, they include scripts within other software they use and a growing number of visual programming languages.

## Code and Conservation

From one point of view, code-based works are among the most archival in the visual arts. Software-based works are fragile in relation to the technologies required to support them, but they are robust because they aren’t embedded into a specific material form like a drawing or sculpture. As introduced by Jon Ippolito in his co-authored book *Re-collection: Art, New Media, and Social Memory* ([Reinhart and Ippolito 2014](#b-9781474207935-013-0000168)), code art can be emulated, migrated or reinterpreted to avoid the issues that cause more essentially physical forms of art to degrade over time. Ippolito defines the most common conservation technique as storage: “Storage captures matter and puts it in a box, on a shelf, under glass, in a climate-controlled vault deep in a mountain. There, stored culture waits in a form of suspended animation” (ibid.: 8). Storage is a poor technique for software-based work, but the other options of emulation, migration and reinterpretation are powerful alternatives.

Emulation is a technique where one computer impersonates another. For example, a MacBook Pro in 2016 behaving like a Commodore 64 from 1982. Using this example, a program written in 1982 for a Commodore 64 can look and feel nearly identical to how it did then. Because new machines are more powerful than the older machines, the older software can be entirely simulated within the new machine with high fidelity. This is a technique the Museum of Modern Art in New York uses to display some of the software-based works in its collection.

More so than with emulation, migration can alter the look and feel of a work. A simple instance is migrating software-based work from an older computer and monitor that runs at 1024 × 768 pixels to a new computer and monitor that runs at 1920 × 1080 pixels. This example changes the work in a significant way: there are now twice as many pixels (twice the resolution) and the aspect ratio has changed from 4:3 to 16:9. Does it significantly change the essence of the work? If yes, is that OK? Is it what the artist wanted? Is the artist, or their estate, involved in the migration? A more minimal migration is to adapt a code-based work from one programming language to another but to keep the display details the same. For instance, to migrate a program from the C++ language to JavaScript. This could be a major change to the code, but only a minimal change to what the audience experiences.

Reinterpretation is the most extreme but powerful conservation technique. In the words of Ippolito, “A reinterpretation sacrifices basic aspects of the work’s appearance in order to retain the original spirit. Rare for the fine arts, reinterpretation is common in dance and theater” ([Reinhart and Ippolito 2014](#b-9781474207935-013-0000168): 10). Reinterpretation becomes a necessity if the original source code isn’t available but a documentation video exists as a reference. Reinterpretation might also be the preferred action defined by an artist to keep a work contemporary, rather than utilizing older hardware and software paradigms.

When examining a software-based work within the frames of emulation, migration and reinterpretation many feel the direction should be indicated by the artist. For example, some artworks require a fixed dimension, which lends them more to emulation, while others are more flexible with resolution so that migration is ideal. For others, the point of the work is to be interpreted in unique ways, so reinterpretation is a good choice. If the artist doesn’t state a preference or it’s not implied through the documentation, the decision falls on the conservator.

## Conclusion

During the last decade, a growing number of scholarly books have been published to discuss the origins of code art in the 1960s. This history and the consensus around code art is in flux and will likely change as new information is published into the future. Artists and scholars have spent time in archives around the globe recently and they are sharing their results to spread new knowledge of this essential time in the development of the visual arts. As a community, this is only the beginning and there are many artists and local movements that remain hidden in archives. Additionally, there’s been less focus to date on what happened after the initial burst led to new exploration and growth in the 1980s and 1990s. The rapid increase in the number of artists using computers at that time makes it difficult to follow then and a challenge to document now. The seeds planted at the beginning had taken root and the volume of artists and exhibitions became too numerous to fit within a coherent narrative.

Over the decades, new communities of artists developed through specific academic programmes, professional organizations and annual events and festivals. Many of these new structures did not focus precisely on Code Art, but they supported it among related areas like media art, generative art, new media, software studies, etc. As one example, the theme of the long-running Ars Electronica festival was “CODE—The Language of our Time” in 2003. Today, some of these organizations are maintaining archives going back for decades. The Ars Electronica archive and the archive of the art exhibitions at SIGGRAPH are two examples.

Code Art has origins going back decades before artists started to write computer code. In the 1960s, technical professionals like engineers and scientists started to write computer code to create aesthetic images. Artists soon followed as they explored writing code as an art practice. This has developed at the edges of different art and technology communities for decades. New kinds of lower-cost computers released in the 1980s allowed code to escape research labs and to enter artist studios where the kinds of work artists created with code and the media they worked with diversified. The wide accessibility of the World Wide Web in the mid-1990s was another moment of change and new forms of code-created art emerged. These topics of “Net Art” and “Art on the Web” are the focus of additional individual entries within this Encyclopedia. Throughout this time, the rapid increase in computing speed and the lower costs of hardware made it possible for artists to explore new visual territory. The domain of generative, real-time art emerged as code could be performed in the moment on screens, rather than rendered in other media like drawing and animation. Right now, we’re within another period of rapid change for code art as people are beginning to collect it in large numbers through the NFT phenomenon and codes for NFTs are starting to be stored on blockchains.

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The first part of this article will explore the question of sound art and its place within new media art history. Sound, as a medium, has shape-shifted a few times within the arts, moving between disciplines, expanding its own terminology, reshaping concepts around interdisciplinarity, interactivity and immersion. In addition, sound and technology have a long historical alignment, yet this relationship is fraught with issues, such as exclusion of access shaped by gender, class and race. Yet sound as a listening practice has moved towards a somewhat non-hierarchical and more accessible medium with the development of non-academic pedagogical resources, and cheaper, more accessible technologies.

The second section will attempt the difficult task of tracing a lineage of types of sound art practice while being as inclusive of artists working in the field as I can. Standard archives “are insufficient to capture the more ephemeral practices now pervasive in a post-disciplinary production” ([Artforum 2020](#b-9781474207935-014-0000092)); however, it is equally if not more difficult to locate the works of artists historically under-represented, particularly women and those from outside the “West.” I have used the resources of those who have attempted to highlight the gaps in our art histories, where histories have been shaped by structural, patriarchal and colonial narratives, which have impacted on many historical narratives ([Olusoga 2017](#b-9781474207935-014-0000228); [Rodgers 2010](#b-9781474207935-014-0000231)).

## What are the Sound Arts?

This is not a simple question, and definitely requires several citations from numerous authors who have written on or about the sound arts. This article will not attempt to address the multitudinous examples of the history written by others, but rather to present my own perspective from an analysis of those works to understand the place for which my practice is sited. For some, sound is the medium in which we explore the concept of a place, moment or experience, for others sound is the outcome of technological interactions or interventions. It can be performative, installed, broadcast or interacted with in a variety of negotiations between sound maker and listener. It can be a way of communicating the audible and inaudible for those who cannot hear, asking the audience to understand that sound is also physical, vibrational and tangible. Sound artists sometimes collect and archive the sounds of others, of voices and histories, of disappearing sonic environments. Sound art can be concerned with developing techniques and technologies of listening, and training others to listen, of making audible an act of social, ecological or technological engagement. But where to start when thinking about sound art and new media? Perhaps it is to recall the Fluxus movement and artists such as Alison Knowles and her *Onion* composition (1971), or the African American artist Ben Patterson and his graphic score *Ants* (1962). These scores embody the ideals of interdisciplinary art making in the early twentieth century, which saw the importance of mixing mediums and ideas, spaces and places for making and presenting. And in this context, it is important to note that although an artist such as Patterson prefigured such actions within the arts of combining performance, visual and sound art, text-based media and instrumentation in a very multidisciplinary way, it was his disgust with the Fluxus movement’s “lack of support for civil rights and anti-war (*sic*) efforts was an important factor in my subsequent ‘retirement’ from the art scene” ([Colter Walls 2016](#b-9781474207935-014-0000124)).

It might be that the earliest technological transformation of sound making, such as Leon Theremin’s new instrument and the artists who exemplified its performative potential from Clara Rockmore to Alexandra Stepanoff, or the very modern and strange concert of new musical instruments, and new sounds, created by Futurist Luigi Russolo with his Intonarumori or Art of Noises. There might be several foundational moments for which sound art, as a new media, begins, crossing over and again and again becoming constantly transformed through interactions with technology, ideas and environments.

Then there are the shifting terms that are appended to the word “sound,” attempts to fix and or find a place for it to belong: sound sculpture, sound art, sound and ecology, which becomes the rather broader term “acoustic ecology.” The word “sound” implying a deep relationship to the engagement, act or construction of a body of work. In the arts where our relationship to the visual is embedded within so much of our structures, sound has a place as a physical medium, one where objects are built for both the ear and the eye to engage with, leaving behind the ambiguous, often difficult link between the sonic arts and music and the sound arts. In this way, the creation of bodies of works, which can be fixed in a space and interacted with, links sound as a medium and concept more closely to the visual arts.

However, identifying sound as media rather than medium is problematic as it ignores the very particular ways in which artists have worked with the aural, oral and audible/inaudible of sound. To work with sound as a medium is to understood it as an aural experience, heard both within and without the body, as ephemeral, something which passes through space and time and leaves only memory as a trace, as embodied, related both to technological experiences of immersive audio and to the experience of folding the sounds of experience into oneself, to have sound written into the bodily experience of a place ([O’Keeffe 2015b](#b-9781474207935-014-0000214); [Skuse 2017](#b-9781474207935-014-0000250)).

Sound art has, at its core, a desire to move the eye away from the centre of all experiences. For many artists when working with sound as a medium, there is a focus on examining the sensory, the sensorial, one where the discussion does not centre on a single sensory experience or moment, but on the navigation of a concept, the development of a methodology and the creation of works of art, where sound is integral to creating a locus of sensation and experience. In listening and working with sound as a medium the artist seeks to draw the listener away from first experiencing sound as the sound of *things*; instead, they rely on the human capacity to listen with “an extraordinary richness of distinction and the capacity to discern minute differences of auditory texture” ([Ihde 2007](#b-9781474207935-014-0000185): 60). Then, they bring an awareness to the relationship between the body and sound/object, whether materialized through audio technologies and heard/felt through the body, or manifested as corporeal objects reflecting sounding concepts, such as Catherine Richards’ *Charged Hearts*. In Richards’ piece the audience holds a bell jar containing a sculpted glass heart. The jar and heart, fitted with sensors, *reads* your heartbeat and transforms this sound/sensation into another material, a phosphorescent cloud, signalling the transformation of one source (sound) to another (gas). This work signals the ‘total immersion of the individual in electromagnetic signals’ ([Dyson 2009](#b-9781474207935-014-0000149): 169); sound is implied as integral, the heartbeat, the sending of pule information, the transformation of one sensory material to another.

## Some Beginnings of Sound Art and Media Types

For most artists, the use of sound within the arts means crossing over and between ideas about music, performance, installation and object-based art. If we look at some of the earliest works of art where sound is at the core or conceptual heart of the work, we see direct links between sculptural processes of making, from Marcel Duchamp’s *With Hidden Noise* (1916) to the multimedia sound works of the Gutai art association in Japan, with works such as Atsuko Tanaka’s work *Bell* (1955), and the ephemeral and philosophical piece *Box with the Sound of Its Own Making* (1961) by Robert Morris. However, sound has also crossed mediums: Max Neuhaus’s *Radio Net* (1977) activated public broadcast media in a way that Musique Concrète composers envisioned with the development of radiophonic art in the 1940s. For artists such as Pierre Schaeffer the radio was ‘this miracle-machine, this chamber of wonders’ which led to the development of works such as *La Coquille à Planètes*, perhaps one of the first radiophonic operas ([Dack 1994](#b-9781474207935-014-0000127): 4). The connections between performance art and sound are as strong as any. Technology has played a pivotal role in this relationship, with tape being one of the earliest and most vital tools for artists to mix and edit sounds for live performance. Alvin Lucier’s groundbreaking “I Am Sitting in a Room” could be seen as the precursor to the performance works of Pamela Z, Kaffe Matthews and Janet Cardiff. That is not to say that any person or moment is in fact the precursor to movements in the sound arts, or even that these movements shaped the development of artists. It is important to acknowledge the diverse ways sound has been integrated into the visual arts, which have been significantly shaped by interdisciplinary collaborations and technological innovations. It would also be easy to say that the works of artists such as Jean Tinguely influenced the creations of Haroon Mirza, but that ignores the actual non-linearity and biased way in which history is written. It also ignores the way in which people have or are denied access to epistemologies, or the way in which certain histories have been exemplified or reified as the ultimate form of knowledge production. Linking earlier practitioners to contemporary artists also denies the voices of those not written into history, yet might have had an influence within the sphere of their creative worlds.

But sound as an idea within the arts is also problematic. It is its own medium, its own art form, part of the broader area of the sonic arts and music technology, and sometimes even a contested site because of these different connections and relationships. In some ways, bringing forward sound into the traditional “white cube space” has led to sound art being defined as a “niche” art form ([Jackson 2018](#b-9781474207935-014-0000188): para. 9). The ontology of sound within the arts or even using the term “sound art” is seen as equally problematic because of the inherent links between music and sound. In using sound as a process for making art there are often crossovers in the orthodoxies related to particular ways of production tied to economy, education and reception ([Toop and Parkinson 2015](#b-9781474207935-014-0000263)).

Yet simultaneously we see that the emergence of technologies from radio to speaker systems and portable recording technologies, and new media technologies from synthesizers to computers and online networks, is shifting how composers/musicians and artists begin to work with sound as material and concept. The process of art making, from performance to public art works, installations, multimedia and multi-sensorial work, sometimes crosses the lines in our understanding of visual art works and new music composition and performance. While the act of making, broadcasting or synthesizing sound has closer ties to that of modern music, from the beginning of the twentieth century with the Art of Noises movement, it is the development of new media technologies that allows for the assemblage of visual art and music concepts to align as *Sound*. Those working across the boundaries of sound, music and art have created innovative works that draw attention to architectural acoustics and perception, the potential of “interdisciplinarity” and “chance.” Fluxus created a moment for sound to emerge as a part of the visual arts but not necessarily a fixed or coherent art form. But the development of artists who cross these branches of sound shows a line of progression from the early twentieth century (e.g. Iannis Zennakis, John Cage, Ben Patterson, Nam June Paik, Charlotte Moorman, Yoko Ono, Alison Knowles, Mieko Shiomi and Annea Lockwood) to contemporary new media sound artists (e.g. Amble Skuse, Samson Young, Christine Sun Kim, Madeleine Mbida and Elsa M’bala). These artists have traversed the questions of “What is art?”, “What is sound?” and “What can be music?”

We see the obvious link between our histories of music composition and the sound arts in the evolution of the score and performance as a work of art, an artefact, alongside the development of new instruments. This process has been replicated and advanced by many artists working in sound. Theresa [Sauer’s (2009)](#b-9781474207935-014-0000239) book *Notations 21* highlighted the very complex and beautiful way in which visual graphics have been developed to connote sound, to make visible the potential audible in the more than 100 graphic scores, some very clearly connected to traditional notation, though very much interpretative works for musicians or other performing artists. Jennifer Walshe’s piece *This Is Why People O.D. on Pills/and Jump from the Golden Gate Bridge* (2004) works very much as a multimedia audio-visual artwork incorporating text, images, the voice, instruments and video work. Marina Rosenfeld’s *Teenage Lontano*, a cover of Ligeti’s 1967 orchestral work *Lontano*, involved the development of a new scored work, with a performance devised for thirty-four teenagers. The teenagers wore headphones and mp3 players, in one ear the singers heard Rosenfeld’s voice, and “sang along,” and in the other ear they heard the space and the singer closest to them. The performance was presented with the audience surrounding them, and the audience surrounded by additional layers of electronic music.

For many sound artists, the presentation of their work takes the form of multiple iterations, sound being seen as both located in galleries, presented in temporal performances and sometimes as online interactive works, such as those developed by Artificial Memory Trace, AGF poemproducer, Annea Lockwood, Pamela Z and Paula Garcia. A number of contemporary artists working in sound, in general, use multiple platforms to develop, install, perform and present their works. In fact, it is simpler to locate sound within new media art rather than the sound arts because the framing is located and connected to technology (Trevor Cox quoted in [Weibel 2015](#b-9781474207935-014-0000275)). When we explore contemporary artists working with sound as a medium, the lines that divide between the ontology of music and art seem to, in some cases, disappear, becoming irrelevant in the process of responding to concepts, new technology and, in particular, space.

Technology, in the context of both technique as it relates to the sound arts and its role within pedagogy and research, inherently contains gendered and racial biases. As Adam highlights, this is evident in “the obdurate nature of the association of masculinity with technology” ([Adam 2005](#b-9781474207935-014-0000071): 10). These biases are not unique to sound and technology but are historical issues. The gendered, racialized and classed dimensions of technology affect its use, dissemination, development and, fundamentally, engagement within the creative arts, including both music technology and the sound arts. The focus on media technology in the production of sound art has systematically excluded communities of artists by maintaining homogeneous forms of music technology courses ([Born and Devine 2015](#b-9781474207935-014-0000109)), thereby barring them from the dialogue and networks that are central to discussions about innovation and access to new opportunities and ideas. We see many examples of this at numerous conferences on music technology, where the attendees are primarily men, and, within the UK, Europe and the US, white males. These spaces enforce the notion of who does and does not belong within this network.

The contemporary place where I sit is to give hope, as we meet a broader spectrum of artists located within this field, a move only made possible by the efforts of numerous researchers, writers, practitioners and groups. A few emerging bodies of work, from books to articles, websites and exhibitions have attempted to redress the focus of the history and development of contemporary sound art works and artists from the white European male perspective. One example is the exhibition “Sounds Like Her,” curated by French Cameroonian art historian, critic and curator Christine Eyene in 2017. This exhibition featured the works of seven female artists from diverse cultural perspectives, whose practice or work for this exhibition had a focus on sound: Ain Bailey (UK), Sonia Boyce OBE RA (UK), Linda O’Keeffe (IE/UK), Christine Sun Kim (US), Elsa M’bala (CM/DE), Madeleine Mbida (CM) and Magda Stawarska-Beavan (PL/UK). The purpose of the exhibition was not to present a single conceptual viewpoint, or to frame the body of work as situated within a feminist or post-feminist context, but, rather, it was to highlight the very diverse ways in which women—such as deaf sound artist Christine Sun Kim—work with sound and within the field of sound art, and how various socio-cultural and gendered experiences, as well as abilities, offer different perspectives on what sound art can be when *difference* is recognized and included.

During my career I found it difficult to locate different forms of sound art practice; this pushed me to reach out to international communities of women, as my background has had a focus on feminist theory and practice. It introduced me to the many ways in which women around the world work with sound as a medium. Several of the resources in this article are from first-hand experience and conversations, workshops and collaborations, online discussion boards, extensive searches, as well as traditional text-based sources. I also recognize that for many contemporary sound artists in the West, or where Western pedagogy takes the lead in academia, there are key influential figures whose influence we cannot ignore, simply because they have been the main source of knowledge for many students, and emerging artists. However, a number of women I have worked with in Brazil have discussed the problem, as they see it, of Western-based music history and theory being the core epistemology, which ignores the cultural practices of sound and music making from the Brazilian context, which is framed by and through colonialism and slavery.

But to ignore the social and political constructs that shape how knowledge is consumed and produced further embeds the patriarchal systems of power production within higher learning and within the arts. As founder of the Women in Sound Women on Sound (WISWOS) organization I have worked with women from around the world who have talked about quite different forms of knowledge sharing, of influences on their practice, of new forms of participatory practices that allow them access to media technology to create new modes of making.

Although the beginnings of sound art may seem very homogeneous, it is not now, and in reality it has never been ([Armstrong 2011](#b-9781474207935-014-0000089); [Born and Devine 2015](#b-9781474207935-014-0000109); [Steinskog 2018](#b-9781474207935-014-0000255); [Thompson 2017](#b-9781474207935-014-0000258)). Rather, it is the disinclination for historians of technology and the arts and sound to include the voices of *others* within these histories, and in some cases the continued lack of attention given to the broader contributions made, more globally, by artists working in sound ([Rodgers 2010](#b-9781474207935-014-0000231)). I am taking the approach of Linda Nochlin ([1975] [2015](#b-9781474207935-014-0000199)), that is, ignoring the question of ‘*Where are all the great women* (and other non-male, non-white) contributors to this area of art practice? We are all quite aware that systems of colonialism, patriarchy—structural, economic and political—have excluded vast numbers of people from the arts and from representation within the arts. Instead, I foreground the present while addressing the recent past contributors to this art form.

The following sections will refer, where possible, to sites and sources which have already, and in greater depth, tried to redress this lack of visibility and inclusion of artists from around the world. Moreover, it is important to frame some of the advances, movements and artworks within their socio-economic and cultural spaces. This allows us to reflect on how certain ideas of privilege and power have come to define the shape of sound in new media art.

## Sound Art An Interdisciplinary Practice

The emergence of new technologies brings with it an endless possibility of new iterations, new hacks and new aesthetics. With advances in immersive media technologies, virtual simulated worlds and the almost endless possibilities within coding languages, artists working with sound as a medium have emerged as some of the most interdisciplinary: from artists working with architectural acoustics and digital standing waves, such as SA/JO, Sabine Shäfer and Joachim Krebs, to Dawn Scarfe’s *Lenses*, a work which makes audible the vibrational acoustics of glass. The artists who work with sound as a medium usually operate in an incredibly inter—if not transdisciplinary way. Additionally, the sound arts are innovative in the inclusion of concepts related to “Listening,” both as a technique within the arts and as acquired social, ecological and artistic methodological practice. The works of artists such as Kirsten Reese, Ximena Alarcon, Antye Greie (aka AGF, poemproducer) and Janet Cardiff have explored how sound technologies can inform a very different kind of art practice by focusing on the differences between Listening and Hearing, whether with technology or through embodied practices. Listening within the sound arts has become a social or political movement and has informed the development of movements such as acoustic ecology ([Barclay 2019](#b-9781474207935-014-0000094); [Grimshaw and Schott 2007](#b-9781474207935-014-0000177); [Truax 2019](#b-9781474207935-014-0000269)), noise studies ([Schwartz 2011](#b-9781474207935-014-0000247)), soundscape studies ([Adams et al. 2006](#b-9781474207935-014-0000074); [Aletta and Kang 2018](#b-9781474207935-014-0000084); [Degen and Rose 2012](#b-9781474207935-014-0000138)) and sonic ethnographic research ([Brady 1999](#b-9781474207935-014-0000116); [Erlmann 2004](#b-9781474207935-014-0000152); [Feld 1993](#b-9781474207935-014-0000161); [O’Keeffe 2015a](#b-9781474207935-014-0000208)). Each field has been shaped by artists and in turn has impacted on the development of new media technologies to enhance listening as a practice within the arts.

The emergence and use of various listening technologies within the sound arts, such as contact microphones, hydrophones and parabolic microphones, have facilitated diverse functionalities. These technologies enable artists like Christina Kubisch, Leah Barclay and Christine Sun Kim to document sounds beyond human hearing and to create artworks that reimagine recorded sounds from inaudible or inaccessible spaces. Since the end of the 1970s Kubisch has developed a series of site-specific works and installations that explore the system of electromagnetic induction. These often take the form of walks where users wear headphones designed and co-constructed by Kubisch that pick up the electromagnetic interference in their environments ([Kubisch 2020](#b-9781474207935-014-0000192)). This practice of mediating inaudible sounds allows the listener to embody and locate themselves within a previously unheard electronic soundscape. Barclay has worked for many years to make the soundscape of our oceans and rivers audible. As a sound artist and environmentalist, she has focused on the capturing and dissemination of these sound environments, exploring active listening as one of the potential tools to mitigate environmental catastrophe. Through her works *Hydrology* and *Listening Underwater*, Barclay has focused on the use of hydrophones not just as a tool for recording, but as a medium and process for facilitating listening within communities ([Barclay 2019](#b-9781474207935-014-0000094)). For Sun Kim, a deaf artist working with sound, sound is not just something heard or audible, but a force that can be contextualized through drawings, body language and performance: “by watching how sound works, I have learned how much it defines a space. Sound is invisible to the eyes but when people react and behave around it, it becomes visible” (Kim quoted in [Eyene 2019](#b-9781474207935-014-0000158): 36).

That is not to say that sound art is primarily located within a technological space; in fact for many artists working with sound, methods such as sound walking or Deep Listening© are often used as public engagement activities as well as forms of creative output. By placing either themselves or other listeners within different soundscapes they hope to activate different forms of engagement with and awareness of various locations. For some this is environmental, for others social and sensory; the purpose, for most artists who use sound listening and walking, is to bring sound to the foreground of a space, to have listeners pay attention to the immersive three-dimensionality of place, to move beyond the visible as the only way in which we locate ourselves. For the mother of sound walking, Hildegard Westerkamp, the “simple activity of walking, listening and sound making, invariably has the effect of not only re-grounding people in their community but also inspiring them about it, by creating a more balanced life between the global attraction of the computer and the local contact and touch with live human beings and reality” ([Westerkamp 2011](#b-9781474207935-014-0000278): 12).

We also have the endless capabilities and possibilities of mobile phone technologies to facilitate mobile sensory ethnographies. Mobile phones allow for the documentation of changing sonic environments, the stories and experiences of the ethnographer/s who participate in this evaluation and representation of different sonic locales. Works such as Milena Droumeva’s “The Everyday Listening Project,” which asked participants to create aural postcards, act as both archive of a sound moment in time and as a sound souvenir to share with others in an immediate way. Multimedia devices enable expanded forms of sound making in contemporary sound art practice as well as sound sharing, with the evolution of audio applications on mobile platforms such as Android or Apple devices. New applications have even allowed for live broadcasting of ambient soundscapes and theatrical performances. However, the focus on general forms of technological development and use by artists in the developed West does ignore the ways in which artists work with sound as a material in developing countries, where reuse, rebuild or hack are necessary processes of making when technology is either unavailable or too expensive to use. In fact, for some artists in sound, sharing both technology and training is a key part of working with sound as a medium. In 2018 while working with a group of women in Brazil with co-collaborator Professor Isabel Nogueira, we found that many of the women working in the sound arts constructed their own technologies for performing or designing sound. Many were self-taught, using YouTube and/or friends or partners to gain the skills necessary to work with sound and technology ([O’Keeffe and Nogueira 2018](#b-9781474207935-014-0000219)). This alters the way in which sound is viewed as a medium; for these women access to technology is seen as a privilege, which sits alongside education in technology, also seen as a privilege and defined pedagogically as quite masculine. Sound technologies then become quite precious, as it takes time to learn how to build your devices, acquire the components and then acquire the skill to play or use them. Moving from one technology to another as they are developed is not seen as frugal or even beneficial, it is defined as quite wasteful and bourgeois.

For Cameroonian artists Elsa M’bala and Madeleine Mbida, the process of documenting sound and movement on the basis of equally exploring cultural practices of listening and performing to sound, while each highlights very different forms of sonic representation. For Mbida sound is visualized through painting. Her work aims to capture the Bikutsi dance style, using colour and line to represent sound as moments of light, bodies and gesture. M’bala’s work, on the other hand, explores embodied knowledge and language, such as in her piece *Addis ’63*, which employs samples from a speech by former Ghanaian president Kwame Nkrumah at the 1963 African Union congress. This approach combines vocal poems and sounds to provoke discussion on topics largely invisible or inaudible to the Northern Hemisphere.

It is difficult in some ways to not see technological determinism in the making of sound art, and the seeming influence of technology, in general, within new media art. However, it is more important to see the relationship between technology and art as a form of social shaping of technology (SST). Social shaping advocates exploring both the macro structures and the micro structures within and around technological development. So, for example, it is important to ask, in what way is access to technology restricted to certain social groups? What education is offered or made available to women, people of colour, or certain social classes? What unique ways are technologies adapted to fit the cultural ethos and forms of artist expression and representation?

The following sections will explore forms of sound art and new media developments, focusing on the ways in which artists have adapted new technologies, repurposing and sometimes redesigning, to give new meaning both to technology and sound. I will start with the most recent developments, working my way backwards through time.

## The New Language of Sound

## AI and Sound

Machine learning and AI research are ever present in our daily lives and subject to constant speculation and scrutiny as to the ethical responsibility of researchers and scientists in their potential application. A growing body of artists have begun to explore these issues, as artists tend to do, and to co-opt this technology to both reimagine its potential as well as examining its place within the arts. Composer and sound artist Rebecca Fiebrink has been one of the leading figures to explore the integration of sound and music and machine learning. She has also been a strong proponent of teaching machine learning to creative practitioners. For Fiebrink, it is not only important to teach machine learning to creative practitioners but we must also examine *how* machine learning is taught. The move from STEM teaching to STEAM (Science, Technology, Engineering, Arts, Mathematics) has “the capacity for creative applications to motivate students from diverse backgrounds to engage with technology” ([Fiebrink 2019](#b-9781474207935-014-0000167): 4). As has been highlighted in recent media publications, AI technology has been found to be both racist and sexist, biases fundamentally appearing in the code data as it acquires knowledge from particular sources and spaces where the structures of exclusion still exist, from education to the internet. Biases have even been found within “the algorithms themselves” amplifying “biases through feedback loops” ([Zou and Schiebinger 2018](#b-9781474207935-014-0000287)). The artist-composers Jlin and Holly Herndon created the music video work *Godmother* using the Spawn AI program. In the words of Herndon, Spawn was trained to compose this work by listening and learning from her godmother, Jlin, and godfather, the programmer and musician Jules LaPlace. For Herndon, who teaches the use of AI, it is important to recognize the limitations of AI, and that it is “important to be cautious that we are not raising a monster” ([Herndon 2018](#b-9781474207935-014-0000183)).

## Coding Sound

Data has become a significant source of inspiration for artists exploring reinterpretations of scientific findings. Often, this involves creatively leveraging the vast amounts of raw data collected by data scientists ([BBC 2019](#b-9781474207935-014-0000100)). For many new media sound artists, the challenge lies in conveying complex datasets to a broad audience. With a history of data sonification that dates back to sonar and Geiger counters, the methods for mapping sound to data are varied, ranging from altering a sine wave’s frequency to represent numerical changes in an auditory graph, to composing orchestral pieces that interpret datasets through the conventions of music theory ([Sawe, Chafe and Treviño 2020](#b-9781474207935-014-0000242): 2).

Coding is a space that has grown significantly on an international level, in part because several platforms for live or interactive coding are now open source, but also as a large political and pedagogical movement to push technology and software as the jobs of the future. The fact that this technological move has, for many years, been dominated by a particular white male structural system has, of course, impacted on those who engage with technology as a medium in the arts ([Armstrong 2011](#b-9781474207935-014-0000089); [Born and Devine 2015](#b-9781474207935-014-0000109); [Butler 2000](#b-9781474207935-014-0000119); [Zorn et al. 2007](#b-9781474207935-014-0000284)). A key problem with the dominant discourse that has emerged in regard to coding and technology is that it ignores “women’s historical place in coding” and the shift in the 1950s from “from female to male labour” ([Alessandrini 2017](#b-9781474207935-014-0000079): 8). Today, many women contribute to and participate in the development of coding-based artistic practices, with sound being a key medium in data-based production and interactivity.

Live coding, interactive coding or machine learning have allowed artists such as Shelly Knotts, Amble Skuse, Rebecca Fiebrink and Joanne Armitage to develop new modes of communicating across disciplinary contexts and generate new aesthetic modalities within the sound arts and computer music. These include new processes of performance and interactivity, “new digital musical instruments controlled by sensors, creating computer-based ‘accompanists’ for human acoustic musicians, tracking and responding to dancers” movements, and building interactive art influenced by data such as audience actions or emotional states’ ([Fiebrink 2019](#b-9781474207935-014-0000167): 31).

The piece *Noise Counterbalancing Silence* by Amble Skuse, in particular, addresses, through technology, the absence of women’s voices in the new music and sonic arts scene. Using the names of over 1,500 women “It brings those names to the concert hall, presents them through the computer’s interface, and asks us to honour those names which have been ignored, removed, or forgotten” ([Skuse 2017](#b-9781474207935-014-0000250): 79). This work is situated within the cyberfeminism realm of non-homogeneous forms of conceptual discourse located within the coding world. In Skuse’s work she dares to expose the gendered space of both the sonic arts/music technology and the world of computer coding. She brings her own body with its different abilities into the space, occupying both the physical and audible real world, identifying the multifaceted ways in which exclusion happens on different bodies. Standing on tiptoe for the duration of the performance she reads the names of female composers and sound artists against the backdrop of an ever-expanding noise emerging from the computer.

From coding data to data sonification we see the process of mapping certain data to produce sound signals. This is sometimes a complex and not always fruitful process as the relationship between the data and the sound can seem so far apart as to be meaningless in its inherent link. However, there is the potential for reproducibility, where the same data “can be transformed the same ways by other researchers and produce the same results and what might be called intelligibility—that the ‘objective’ elements of the original data are reflected systematically in the resulting sound” ([Graham 2016](#b-9781474207935-014-0000172): 1). As in Geiger and sonar technology, creative data sonification has the potential to articulate and convey scientific findings to a non-scientifically literate audience. The question of whether it adds to scientific findings is still in debate, though some sci-art collaborations, such as Kaffe Matthews’ work *Biotec Orchestra*, a collaboration between humans, ‘plants, software, self-made electronic instruments and lights’, explores the potential macro and micro interactions that can occur through and audio-visual loopback. In this work, bio-feedback is sent from the plants to self-made instruments to make audible the micro interactions of plants with light, water, heat, etc. Even more interesting, the sounds produced, including music and text, are then fed back to the plants, which are then monitored for reactions, changes in growth—a form of sonic sculpture of a natural ecological system.

Within the realm of the sound arts and data sonification some of the most successful works create clear links between the sounds produced and the data being read. One of the key collectives working in this area is Softday. Formed in the 1990s, this duo of Mikael Fernström and Sean Taylor created several large-scale sound art and performance works using extremely large databanks. One of their first major projects was a collaboration between Softday and marine biologists and marine scientists: using tidal flow data, weather statistics and data from underwater mapping, they examined the emergence of dead zones in the ocean, at the time speculating on the impact of climate change and underwater pollution. Using this data and working with communities they produced several artistic outputs. The *Marbh Chrois* (Dead Zone) project in 2010 addressed the impact of two “contested” marine dead zones as a key stressor on marine ecosystems in Donegal, Ireland. During a personal communication with Mikael Fernström via Facebook roughly six years ago, and through various subsequent discussions about their project, he shared insights into how the Marbh Chrois (Dead Zone) project operated with extensive environmental and scientific data. According to Fernström, the project utilized data “from Buoy M4 for several years,” including parameters such as Atmospheric Pressure, Wind Speed, Max Gust, Wind Direction and several other metrics. This data informed the creation of ‘orchestral score(s) and profiles for making some synthesised timbres’.

Collaborating across data-led disciplines has produced a significant and innovative approach to art making, where data becomes the principal guide in the process of developing bodies of work from performance through to installations. Artist and performer Shelly Knotts collaborated with Agnieszka Bronowska (lecturer in computational medicinal chemistry) to develop the body of work *Molecular Soundscapes*. In this astonishing sci-art collaboration Knotts and Bronowska have “looked at new ways to represent the effects of drugs on proteins in the human brain by turning their movements into sound” ([Knotts 2017](#b-9781474207935-014-0000190)). In the resultant sound installation, the audience hears a sonification of complex scientific data, whereby changes in timbre and pitch reflect the shape, structure and trajectory of these proteins in the brain.

It is significant that female-identifying artists/coders and people from the black community are under-represented in the coding, computer science and computer music community. It is necessary to understand that coding languages, the same as any other new technology, have rules of development, use and meaning that have been shaped by a single social group. This has fundamentally led to the exclusion of others from engaging with this technology.

## The Body and Technology—Performance in the Sound Arts

The body has played a significant role in aligning processes of immersive technology and code space into performance art. The use of the body and movement in sound technologies can be traced back to the Theremin performances of Clara Rockmore, a Russian virtuoso of this electronic instrument. The body and technology have a strong lineage in the sound arts, from Alvin Lucier’s Vespers, a handheld echolocation instrument where bodies move blindfolded through a room triggering sounds as they come close to walls, to Krzysztof Wodiczko’s *Instrument Osobisty* *1969*, which included objects designed to be worn on the hands and body. *Instrument Osobisty* responded to the wearer, making it possible “for the individual to amplify or diminish the flow of sounds from the environment” ([Weibel 2015](#b-9781474207935-014-0000275): 619). However, there have been many multimedia works where there are strong sound- and audio-related elements that have combined the body with technology, such as Laurie Anderson’s *Handphone Table* to Kaffe Matthews’ *Sonic Bed*, where in both cases the audience participation is quite literally embodied: their bodily actions, with the objects, allow for the flow of sound through the body. The idea is that sound is not just heard through the ears: it resonates and moves through our organs and bones, and that our relationship to sound is in fact immersive and phenomenological, whereby we understand that sounds exist both inside and outside the listener ([Ihde 2007](#b-9781474207935-014-0000185)).

The 1990s saw a new wave of technologies emerging within the performance space, most built to enhance new forms of sound making. This crossed popular music forms with techno music, moving into the sonic arts and new music scene. A number of these technologies were very much connected to haptics, wearable technologies and bodily interactivity—the ability to manipulate sound through different forms of bodily interactions. One of the most important performance artists to emerge within this genre of embodied and wearable performance technology is the African American composer and performer Pamela Z. In the 1980s Pamela’s work was shaped largely by live audio processing; it wasn’t until the late 1990s and early 2000s that she started to combine Cycling 74’s Max MSP (Max Signal Processing) with gesture controllers to create performances that involve the use of the body and movement, vocal sounds and live signal processing. Her performance with BodySynth, created by Chris van Raalte and Ed Severinghaus in 1994, involves a series of electrodes covering various muscles which “allow her to manipulate sound with physical gestures”; in this fusion of movement, technology and the production of sounds, we see what cyberfeminists call the synthesis of biology and technology ([Haraway 1990](#b-9781474207935-014-0000180)). Her continued engagement with embodied technologies amplifies the relationship between the body and sound, using gesture and movement in performance to create a body–sound link which amplifies sonic territories.

Cyberfeminism has had a long relationship with the DIY movement. In Pamela’s approach to performance and the sound arts, we see an intricate assemblage of technological and creative ideas that allow her to enhance her performance practice. In her work we also see a combination of interdisciplinary concepts and the use of language, spoken word, abstraction, repetition, associations and disassociations of and to bodies in other spaces. The divide between digital and acoustic, live and preprogrammed, the body and machine are becoming technologies, used by women, to enhance a body–sound technology relationship in performances. Most of these women came from very different backgrounds, but had a common goal, to find ways in which technology and their bodies could enhance the performing experience.

## Conclusion

The examination of theoretical and historical contributions to the fields of new media and sound art, and music technology, tend to render out of place certain bodies from history and culture ([Rodgers 2015](#b-9781474207935-014-0000234)). In Steinskog’s *Afrofuturism and Black Sound Studies* ([2018](#b-9781474207935-014-0000255)) we are presented with the case study of the different trajectories of black composers, musicians, sound artists and technologists, which are in turn influenced by alternative visions of both mainstream culture and future technologies. This perspective is informed by an awareness that “African-American voices have other stories to tell about culture, technology, and things to come” ([Dery 1994](#b-9781474207935-014-0000143): 182). While this article cannot offer a fully inclusive rendering of the contribution of sound artists from around the globe, it is necessary to bring attention and awareness to those who have contributed and note and understand the absence and silence of people not present. This article strives to list as many diverse artists as possible within the multitudinous types of new media sound art processes developed over the past century. However, it cannot list all contributors from history who have been ignored, for the reasons discussed. Instead, where possible, it is important to look for artists in sound from the corners, networks and places that you haven’t explored before.

Many non-European and North American composers are now celebrated and retrospectively brought into the fold of the sound arts ([Damião 2019](#b-9781474207935-014-0000132); [Obici 2019](#b-9781474207935-014-0000202); [Weibel 2015](#b-9781474207935-014-0000275)), with the never-ending examination of the inclusion of women in these media histories ([Born, Devine, Norman and Taylor 2014](#b-9781474207935-014-0000114); [Eyene 2019](#b-9781474207935-014-0000158); Mello Neivo, Porto Nogueira and Durães Zerbinatti 2019; [Rodgers 2010](#b-9781474207935-014-0000231)). This is not to create alternative histories or to suggest they had a bigger role in shaping the art of their time. However, we must be aware that many forces are at play to actively exclude certain groups from making significant impacts on a variety of fields ([Nochlin 2015](#b-9781474207935-014-0000199)). Raising awareness, bringing to the foreground the contributions of a wide field of artists, points to where art making and new ways of thinking about sound were and are emerging, away from mainstream pedagogical institutions, still framed by European patriarchal epistemologies. It speaks to the contestation of the great single, lone figure, often characterized as a white male, making the significant body of work that changes all work that follows. Instead, with a broader perspective of our field of sound as new media art, we see the expansive nature, the multidisciplinary perspective, the socio-cultural particularities, the way class, gender, race and ability shape how we engage with modes of hearing, listening and sounding when working with new media technology.

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Since the early 1990s, art has had a continuous presence on the World Wide Web (WWW) and has critically engaged with or even contributed to the development of its potential for visual expression. Art on the Web is by nature embedded in the complex protocols and information spaces of the internet and, from its early stages, has often been about the network in that it has reflected upon its evolving processes, platforms and commercial frameworks. The different stages of this evolution—most notably the transition from Web 1.0 to 2.0 and the so-called post-internet era—have shaped the art form itself and will be discussed with regard to specific forms of artistic engagement in the following.

The art commonly referred to as internet art or net art officially came into being with the advent of the web in the early 1990s. Conceptualized by Tim Berners-Lee and CERN, the European Particle Physics Laboratory, the WWW was created with the intention to build a distributed collaborative multimedia information system. On the basis of the Hypertext Transfer Protocol (HTTP), the WWW allows one to access documents written in HTML (Hypertext Markup Language), making it possible to establish links between documents and arbitrary nodes. While art platforms such as Robert Adrian’s ARTEX (1980) and the New York-based The Thing (founded by Wolfgang Staehle in 1991) had existed as a Bulletin Board Service (BBS), an electronic messaging system, before the launch of the WWW, the early and mid-1990s saw a new wave of web-based projects that marked the arrival of net art as an art form.

Just like the original internet, the global system of interconnected computer networks built from 1969 onwards, the early WWW, which was launched in 1991 and enabled content sharing over the internet-linked webpages, was dominated by education and research institutions, a largely unregulated space for free information sharing. As with the arrival of the first Portapak video cameras in the late 1960s, the utopian promise of the WWW era of the 1990s was “technologies for the people” and a many-to-many broadcasting system that returns the power over distribution to the individual and has a democratizing effect. In its early days, the web provided a playground for artistic experimentation. The dream of a “network for the people” did not last long and, from the very beginning, obscured the more complex issues of power and control over media. The web quickly became a mirror of the actual world, with corporations and e-commerce colonializing the landscape. The burst of the “dot-com” bubble around 2000 ended a lot of the hyperbole surrounding the internet economy and led to reconsiderations of e-commerce, until the arrival of so-called “social media” a few years later started yet another boom.

One can argue that networked environments enhance the potential for democratization and increase the public’s agency through enhanced distribution, filtering and archiving mechanisms that give importance to the voices of individuals or groups, as has been seen in pro-democracy or anti-racism movements around the world. This obviously does not mean that authority itself has been eliminated, and web-based art is in many ways characterized by the tension between the philosophy of the free networked space and its existence in a commercial context.

Art existing in the public space of networks can be considered a new form of public art. Compared to more traditional forms of public art practice, net art introduces a shift from the site-specific to the global, collapses boundaries between the private and public, and exists in a distributed non-local space. As opposed to public art in physical space, artworks in the public space of networks are largely not regulated and sponsored by the government, although increasingly dependent on corporate platforms. Within this macrocosm governed by multiple layers of protocols and providing different levels of access, individual projects and sites can again create public spaces, dependent on their openness to public contribution.

By its very nature, art *on* the web often is art *in* the web: a multitude of online art projects use, recycle, reproduce or recontextualize information from the network or use its commercial platforms to stage performative interventions. While many net art projects may also be *about* the web in that they comment on its framework and processes, the concept of art about the web has gained new meaning with the emergence of so-called post-internet art.

As digital technologies have affected almost all aspects of art making, many artists, curators and theorists have already pronounced an age of the post-digital and post-internet that finds its artistic expression in works both deeply informed by digital technologies and networks, yet crossing boundaries between media in their final form. The term “post-internet art” attempts to describe a condition of artworks that are conceptually and practically shaped by the internet and digital processes—essentially being *about* the web—yet often manifest in the material form of objects such as paintings, sculptures or photographs. The condition described by the “post-” label is a “post-medium” one in which media in their originally defined format—for example video as a linear electronic image—cease to exist and new forms of materiality emerge. Rather than suggesting a temporal condition of being *after* the internet, the post-internet label suggests that artistic practice has moved beyond it. The rapid spread of the post-internet concept throughout art networks testified to a need for terminologies capturing a certain condition of cultural and artistic practice in the early twenty-first century: the confluence and convergence of digital technologies in various materialities; and the ways in which this merger has changed our relationship with these materialities and our representation as subjects.

Art in, on and about the web has become a broad umbrella for numerous forms of artistic articulation that often overlap. The dominant forms of this expression are projects

* exploring narrative forms by audio-visual and/or textual means or using the browser window as canvas for formal experimentations;
* recycling and recontextualizing online materials;
* filtering, archiving and visualizing public contributions or collaborative creation in virtual public space;
* creating platforms for audiences, enabling them to participate in the creation of work through contributing, assembling or rearranging constituent elements;
* manifesting as performances on platforms ranging from early chat rooms and mailing lists to online games and Facebook, YouTube and Twitter, where they can be experienced by web visitors worldwide;
* engaging in net-activism, using the web and its possibilities of instant distribution and copying of information as a staging platform for interventions, be they support of specific groups or a method of questioning corporate and commercial interests.

The following will provide a more detailed outline of the evolution of art in, on and about the web and its conceptual and aesthetic frameworks in the Web 1.0 and 2.0, as well as post-digital era.

## Net Art 1.0

From its inception net art inspired a variety of dreams about the future of artistic and curatorial practice, among them the dream of a more or less radical reconfiguration of traditional models and spaces for producing and accessing art. As an art form that exists within a virtual public space and has been created to be seen by anyone, anywhere, at any time—provided one has access to the network—net art does not necessarily need the physical space of an art institution to be presented or introduced to the public and promises new ways of distributing and accessing art that can function independently of the institutional art world and its structures of validation and commodification. Net art seems to call for a distributed, living information space that is open to interferences by artists and audiences—a space for exchange, collaborative creation and presentation that is transparent and flexible.

In the early and mid-1990s several “movements” of artistic practice on the web developed at the same time. A core group of European artists, among them Russian artists Olia Lialina and Alexei Shulgin, British artist and activist Heath Bunting, Slovenian Vuk Ćosić, and the artist team JODI (Joan Hemskeerk and Dirk Paesmans), who were connected through the online mailing list nettime—founded by media theorists and critics Geert Lovink and Pit Schultz and devoted to internet culture and criticism—drew attention to the genre of art on the Net and formed the net.art (with a dot) movement. The term was officially used for the first time when Vuk Ćosić organized a small gathering—“net.art per se”—in Trieste in 1996. Discussions about the net art genre also took place on Rhizome, a New York–based online forum for new media art founded by Mark Tribe. Among the artists shaping the emergence of net art in the US were Lisa Jevbratt, Yael Kanarek, Mark Napier, Vivian Selbo, Wolfgang Staehle, Martin Wattenberg and Maciej Wisniewski.

The early WWW was a largely textual and not very sophisticated medium, and early net artworks were often very conceptual, driven by a sense of community and a spirit of spontaneous interventions. In 1997, Alexei Shulgin arranged the WWWArt Award, which consisted of found sites that were given awards in categories such as “Research in Touristic Semiotics,” which went to a guide for common traffic signs around the world, or “Flashing” (blinking images were a characteristic of one of the web’s developmental stages). He also organized the Form Art Competition ([1997](#b-9781474207935-015-0000133)), asking contributors to create art out of formal elements, such as radio buttons, scroll bars and pull-down menus. Vuk Ćosić popularized ASCII art, creating still images and videos that are made entirely out of alphabetic and numeric characters. With Walter van der Cruijsen and Luka Frelih, Ćosić made works under the label ASCII Art Ensemble. The duo JODI literally turned the common web interface and desktop elements inside out: pages of seemingly “broken” HTML with integrated scroll bars and icons brought the desktop to the foreground of the web page. JODI’s site was a decidedly low-tech graphics battle—a reminder of the standardization of the interface and the inherent beauty of its form elements and “sign language.”

Early net art exploring narrative forms produced some classics of the genre, among them Olia Lialina’s *My Boyfriend Came Back from the War* ([1996](#b-9781474207935-015-0000115)) and Heath Bunting’s *Read Me (Own, Be Owned or Remain Invisible)* (1998). Lialina’s piece is a reflection on “wars” (literally and metaphorically) and communication over the web. Clicking on the black-and-white images, questions and statements in the frames of the browser window causes a split of the frame (and conversation) into subdivisions of increasing complexity. Bunting’s *Read Me* consists of a short biographical text about the artist, in which every word is linked to its corresponding domain name—the word “is” links to is.com, for example, “qualifications” to qualifications.com, etc.—indicating that presence and identity on the web are a matter of owning domains and language, being owned or remaining invisible.

Within this network of the web, information is subject to infinite recycling and reproduction, two concepts that form the basis of a multitude of online art projects. These range from the so-called web colliders of the 1990s—projects that mix existing information and make it “collide” into new forms—to the online remix culture of the twenty-first century. The *Unreliable Archivist* ([1998](#b-9781474207935-015-0000091)) by Jon Ippolito, Keith Frank and Janet Cohen, for example, uses the projects featured on the online gallery platform äda’web as its raw material and allows visitors to reconfigure them. By adjusting four sliders (language, images, style, layout) to the categories “plain,” “enigmatic,” “loaded” and “preposterous,” users can select text and visuals from any of the äda’web projects, which are subsequently displayed on the screen in a collage. Authorship and boundaries of the original projects are erased, and the context for understanding the collage is largely set by subjective categories determined by the Archivist’s creators. A different approach to the “remix” was taken by the British duo Thomson & Craighead (founded in 1994; Jon Thomson and Alison Craighead) in their project *CNN Interactive Just Got More Interactive* (1999), which adds a separate browser window to the CNN site that functions as a kind of music box and allows users to add a variety of soundtracks to the news provided by the site. Mixing fact and fiction, *CNN Interactive* unveils and adds to the infotainment aspect of the economy of news.

Many art projects within the public space of the web filtered, visualized and thereby provided new insight into the information available on the web or contributions by or communication of the public. A genre specific to the net art of the 1990s was so-called browser art, the creation of alternative browsers. Browser art filtered and visualized information available on the web in new ways, thereby rewriting the conventions underlying our experience of the web through browsers such as Netscape and internet Explorer. The ways in which we usually experience information on the internet are based on conventions rather than any inherent characteristic of the medium: we are viewing websites through the portal of browsers that are ultimately based on the page model of the printed book (or even the ancient format of the scroll). In the early days of the web, numerous art projects questioned these conventions. The British group I/O/D single-handedly established the genre of alternative browsers with the WebStalker ([1997](#b-9781474207935-015-0000109)), an application that allows users to draw frames in a blank window and select information they would like to display in them—for example a graphical map of the site that presents all its individual pages as little circles and the links between them as lines; the text from a URL and the source code of the HTML page; and a “stash” of URLs users would like to save. Although the WebStalker did not display graphics, it expanded the functionality of existing browsers in an aesthetic and creative way that questioned the paradigms of the conventional information display and internet architecture. A different approach to experiencing content on the web was New York–based Maciej Wisniewski’s netomat™ ([1999](#b-9781474207935-015-0000150)), which abandoned the page format of traditional browsers and treated the internet as one large database of files. In response to words and phrases typed in by the viewer, netomat™ dialogues with the internet to retrieve text, images and audio, and to flow them simultaneously onto the screen without regard to the display design of the data source. Using an audio-visual language designed specifically to explore the unexplored internet, netomat™ reveals how the ever-expanding network interprets and reinterprets cultural concepts and themes and takes visitors for a ride into the internet’s “subconscious.” Netomat™ is also notable in that it is a crossover between an artistic and commercial context. Originally an art project, Netomat is also a company that sells a suite of products for mobile devices based on its underlying language. The WebStalker and netomat™ are just two examples of browser art that redefined the conventions of our network experience. A project with a more explicitly political twist is Mark Napier’s *Riot* (1999), a “cross-content” web browser that combines in one browser window text, images and links from the three most recent URLs that *Riot* users worldwide have accessed. The basic functionality of *Riot* is still rooted in traditional browser conventions: users surf the web by entering a URL into the location bar, or by selecting from bookmarks. However, the project blends different websites—for example those of CNN, the BBC and Microsoft—and, by collapsing territorial conventions like domains, sites and pages, illustrates how the Net resists traditional notions of territory, ownership and authority. What all these projects have in common is that they allow to experience the network in a way that is radically different from the one provided by pre-configured and corporate portals.

One of the most significant aspects of the web is that it has created a global platform for exchange and communities of interest. The filtering and visualization of communication processes also developed into its own area for artistic exploration. An earlier, well-known graphical representation of large-scale communication was *Chat Circles* (1999–2005) by Judith Donath and Fernanda B. Viégas. Each person connected to the chat environment is represented as a coloured circle with the person’s name attached to it. If users post a message it appears within their respective circle, makes the circle grow and then gradually fades as time passes. Projects such as Warren Sack’s *Conversation Map* ([2001](#b-9781474207935-015-0000131)) early on experimented with the mapping of communication: the *Conversation Map* is a browser that analyses the content of large-scale online email exchanges (such as newsgroups) and uses the results of the analysis to create a graphical interface that allows users to see different social and semantic relationships.

Another area of artistic practice within the public space of the web consists of the creation of platforms for audiences, enabling them to participate in the creation of work through contributing or assembling constituent elements. Participation and collaboration are inherent to the networked digital medium, which supports and relies on a constant exchange and flow of information, and the collaborative model is a crucial concept when it comes to the artistic process itself. One form of collaboration occurs in projects where an artist establishes a framework in which other artists create original works. Early examples of this approach would be Lisa Jevbratt’s *Mapping the Web Infome* ([2001](#b-9781474207935-015-0000111)) and *Carnivore* ([2001](#b-9781474207935-015-0000101)) by Alex Galloway and the Radical Software Group (RSG). In both cases, the artists set certain parameters through software or a server and invite other artists to create “clients,” which in and of themselves again constitute artworks. In these scenarios, the initiating artist occasionally plays a role similar to that of a curator, and the collaborations are usually the result of extensive previous discussions, which sometimes take place on mailing lists specifically established for this purpose.

Other net artworks are ultimately created by audience input, which constitutes another manifestation of an artwork as “platform” and level of participation, although not necessarily collaboration in the narrower sense. While the artists still maintain a certain (and often substantial) control over the visual display, the resulting images would all consist of a “blank screen” without the audience’s contribution. Mark Napier’s *P-Soup* (2000), Andy Deck’s *Open Studio* (1999) or Marek Walczak’s and Martin Wattenberg’s *Apartment* (2001) were early prime examples of this participatory practice. These projects ultimately are software systems in which the creation of meaning to varying degrees relies on content provided by the audience, collector or curator. The artist often becomes a mediatory agent and facilitator—for collaboration with other artists or for audiences’ interaction with and contribution to the artwork. The existence of networks opened up new spaces both for autonomous producers and DIY (Do It Yourself) / DIWO (Do It With Others) culture, and the industry of market-driven media. Artistic production oscillates between the poles of openness of systems and restrictions imposed by protocols and the tech industry.

The web early on was used for performative interventions taking place in online multi-user environments, chat rooms or games. The possibilities for remote communication established early on by mailing lists were followed by 2D chat environments and then virtual worlds and online chat that allowed multiple users to engage in live conversation. Among the early multi-user environments that developed on the web were the so-called MUDs—Multiple User Dungeons (or Domains)—which were modelled after the early text-based *Dungeons & Dragons* computer games in which players navigate through the environment by typing in textual commands. Online MUDs were based on the same principles but allowed thousands of players to navigate through the rooms, interact with each other and engage in role-playing games. MUDs found their extensions in MOOs (MUDS Object-Oriented), which are based on more sophisticated object-oriented programming and can be expanded by their users. MOOs lend themselves to the construction of anything from adventure games to conferencing systems, and many universities built MOOs that focused on a specific topic of research to enable students and faculty to engage in ongoing discussions. Chat environments entered a new phase with graphics-based worlds like Time Warner Interactive’s “The Palace,” which visually represented its rooms and buildings, as well as their inhabitants, and made the communication between people visible in cartoon-like speech bubbles. Several early virtual worlds were created in VRML (Virtual Reality Modeling Language), the 3D counterpart of HTML, and were then superseded by environments such as Second Life. Over the years, numerous artworks have used multi-user worlds, be they text or graphics based as performance spaces. In their project *Desktop Theater* (1997), Adriene Jenik and Lisa Brenneis “invaded” The Palace chat environment and used their avatars to stage performances, such as an adaptation of Samuel Beckett’s *Waiting for Godot*. The theatrical interventions (in which anyone can take part) become experimental investigations of the virtual as performative environment.

Network structures and collaborative models tend to create zones of cultural autonomy—often formed ad hoc by communities of interest—that exist as long as they fulfil a set of functions and then often disperse or move on. This does not necessarily mean that networks create new models of democratic engagement or self-governance, since they are supported by numerous protocols and governing structures and inextricably connected to the technological industry.

The public space of the online environment was also used for critical and activist interventions early on. The Electronic Disturbance Theater framed its actions as “electronic civil disobedience” and staged a number of virtual “sit-ins” in support of the Zapatista rebels in Chiapas, Mexico, by using self-authored web-based software called FloodNet for disrupting the service of targeted websites (such as the sites of the president of Mexico and the US Department of Defense). Interventions into online games include the project *Velvet-Strike* ([2002](#b-9781474207935-015-0000093)) by Anne-Marie Schleiner, Joan Leandre and Brody Condon, which was conceptualized as a direct response to President Bush’s so-called “War on Terror.” *Velvet-Strike* is a collection of graffiti that can be “sprayed” on the walls and rooms of the shooter game *Counter-Strike*, a multi-user game that allows participants to play either as members of a terrorist group or as counterterrorist commandos. Putting the “weapon” of public opinion back into the hands of the players, *Velvet-Strike* enables users to spray their anti-war graffiti (one of them reads “Hostages of Military Fantasy”) onto the walls of the game environment.

The regime of racial classification on the internet was addressed by Mendi + Keith Obadike’s *The Interaction of Coloreds* ([2002](#b-9781474207935-015-0000126)), part of their Black Net.Art Actions. The work was created at a time when online commercial ventures were positioning the internet as a space without prejudice, free of mediation through our physical appearances and therefore notions of race itself. Drawing attention to the fact that there still is a strong link between skin colour and money in the filtering and tracking involved in online commerce, the artists create a satirical Color Check System. Billed as the world’s first online skin colour verification system, their website enables the translation of skin colour into the six-digit, three-byte hexadecimal numbers used in HTML, the online scripting language, to represent colour (#FFFFFF, for example, equals white). Using satire as a strategy, the work strives to put pressure on conversations about race on the internet.

Multi-user environments and performative interventions also brought about experimentation with assumed identities through avatars, a term originating from Hinduism and meaning “descent,” most commonly the descent of a deity to earth in an incarnate form (definitions tend to vary depending on the source). While it may be difficult to trace exactly how the term entered cyberspace vernacular, it is at least interesting to note its connotations in the context of identity and community on the internet and the upload and download (descent) of information to and from the server.

An online art world—consisting of artists, critics such as Tilman Baumgärtel and Josephine Bosma, curators, theorists and other practitioners—immediately developed in tandem with internet art and outside of the institutional art world, and the early phase of artistic practice on the web was profoundly shaped by the support and infrastructure of online galleries. Among the early ones was Benjamin Weil’s äda’web, a digital foundry that featured work by net artists as well as established artists, for instance Jenny Holzer and Julia Scher, who expanded their practice with the new medium. In the early years, funding strategies for net art and online galleries were as experimental as the art itself. The Machida City Museum of Graphic Arts in Tokyo started sponsoring a competition for “Art on the Net” in 1995, but recognition for net art in the art world at large would remain scarce until the end of the century. In the late 1990s, institutions also began to pay attention to net art as part of contemporary artistic practice and slowly incorporated it into their programming.

The Walker Art Center’s online exhibition space Gallery 9, developed from 1997 until 2003 under the direction of its founding director Steve Dietz, acknowledged the need for a “living,” more discursive environment with multiple perspectives beyond the institution from its inception and was created as an online venue for both the exhibition and contextualization of internet-based art. Gallery 9 also became a permanent home for content that was not originally created by the Walker Art Center. After äda’web lost its financial support, the gallery and its “holdings” were permanently archived at Gallery 9. Another part of the gallery’s archive is G. H. Hovagimyan’s *Art Dirt*, an online radio talk show that was originally webcast from 1996 to 1998 by the Pseudo Online Network. Gallery 9 quickly became one the most recognized online venues for net art worldwide and the leading initiative of its kind in the United States. To the shock and surprise of the online community, the Walker Art Center abandoned its new media initiative in 2003, presumably unaware of the fact that it was the most important programme of its kind in the US (and arguably worldwide) at the time. Gallery 9 also was a model for the Whitney Museum’s artport, a website designed as a portal to internet art and online gallery space, conceived and created for the museum in 2001.

The most fundamental support for online art was provided by non-profit organizations devoted to the art form. The oldest and longest-running site supporting net art is Rhizome, founded as an online platform by Mark Tribe in 1996 and an affiliate in residence at the New Museum in New York City since 2003. Another pioneering organization was turbulence (1996–2015)—a project of New Radio and Performing Arts and its co-directors Helen Thorington and Jo-Anne Green—which, in addition to commissioned projects, featured curated exhibitions (often organized by artists) as well as “Artist Studios” that presented artists’ works and provided context for them through writings and interviews. In 2004, turbulence.org began a curatorial partnership with low-fi, embedding it within turbulence’s homepage until 2006. This curatorial contribution to turbulence.org was a prototype for a distribution system co-existing symbiotically on other sites.

## Net Art 2.0

The notions of internet art and the public spaces it occupies have considerably shifted from the 1990s into the first decades of the twenty-first century. From the early 2000s onwards, web-based art practice entered another phase with the proliferation of the blogosphere—the online sphere of interconnected weblogs and their communities—and social media sites where user-generated content became aggregated on corporate platforms as a set of services, tools and products. As a corporate concept, these platforms provide contextual “warehouses” that allow for the filtering and networking of content provided by users, whether photos (Flickr, 2004; Instagram, 2010), videos (YouTube, 2005), personal profiles (MySpace, 2003; Facebook, 2004) or microblogging (Twitter, 2006; Tumblr, 2007). Creating public space by means of highly accessible and scalable publishing technologies, the so-called second generation of web-based services, became known as “Web 2.0,” a term coined by O’Reilly Media in 2004.

Artistic practice both helped to initiate and responded to the move from the 1.0 to 2.0 version of public networked environments and their respective articulation of data spaces and collective production. The corporate platforms of Web 2.0 quickly became spaces for the creation of art. The net art 1.0 of the 1990s predominantly existed as discrete websites, which would be accessed from one’s home or office computer. The net art of the Web 2.0 era increasingly became networked art, being accessible on multiple platforms, from one’s computer to one’s smart phone, and taking multiple forms, from a website to an app.

The public space of Web 2.0 is a hyperlinked broadcasting environment with meta-tags and, at the same time, broadens the idea of the cultural commons and its platforms, which assist creative and cultural communities in staying informed and improving policies that shape cultural life.

The microblogging site Tumblr, initiated by David Karp in 2006, became a particularly popular platform for artistic visual experiments. The fact that Tumblr allows for quick and easy reblogging of content, is highly customizable and provides a continuous feed from the blogs one is following creates an image space that is both interestingly non-hierarchical and undermines authorship and attention to singular imagery. Artists engaged with the platform for both of these reasons. Joe Hamilton’s Tumblr *Hyper Geography* ([2011](#b-9781474207935-015-0000107)), for example, creates a highly customized collage that makes images flow together in a continuous space, thereby creating a landscape that simultaneously flattens distinctive qualities of images and provides a portrait of the Tumblr environment and the aesthetics of its imagery.

The Web 2.0 era brought forth the phenomenon of Big Data—collections of datasets so complex that they required new software tools for capture, search and analysis—which led to a new stage for artistic practice in the area of data filtering and visualization. Big Data analytics, the process of examining the Big Data generated by public contributions to the web in order to uncover hidden patterns and unknown correlations, became a subject in art. The recycling and data visualization artworks of the 1990s found their continuation in projects such as *The Aggregate Eye* ([2013](#b-9781474207935-015-0000087)) by Lev Manovich, Nadav Hochman and Jay Chow, which investigated urban representations through the aggregation of the millions of photos shared by people on social networks. The collaborators downloaded and analysed 2,353,017 Instagram photos shared by 312,694 people in thirteen cities over a three-month period. The online representation of the work combines these photos to reveal unique patterns. One set of images compares New York, Tokyo and Bangkok on the basis of 150,000 Instagram photos. A visualization of 23,581 photos shared in Brooklyn during Hurricane Sandy captures the visual narrative of that day. *The Aggregate Eye* is a part of Phototrails, a research project initiated by Hochman, Manovich and Chow that uses experimental media visualization techniques for exploring visual patterns, dynamics and structures of user-generated shared photos. Tools for data visualization are typically accessible in the context of academia, business or government. In an attempt to “democratize” visualization and enable collaborative techniques, Martin Wattenberg, Fernanda Viégas and collaborators built *Many Eyes* ([2007](#b-9781474207935-015-0000141)), a website where people could upload their own data, create interactive visualizations and discuss them together. *Many Eyes* functions both as a tool and artwork that creates a framework for public sharing.

The blogosphere provided platforms for “surf clubs,” collaborative blogs created to share media artefacts such as Nasty Nets (2006–12) and Loshadka (2009–14). Artist Harm van den Dorpel’s Club Internet (2008–9) hosted exhibitions such as Guthrie Lonergan’s “Tag Team” and Constant Dullaart’s “K.I.S.S.” Artist collectives such as VVORK (2006–12), founded by Aleksandra Domanović, Oliver Laric, Christoph Priglinger and Georg Schnitzer, explored the blog as both site of artistic and curatorial practice by using reposting and tagging as curatorial strategies in the filtering of visual content consisting of found images, challenging conventional methods of classification.

The collaborative production on platforms for user-generated content increasingly raised the issue of the “labour conditions” of public art in the networked space, and art projects specifically engaged with that aspect. Aaron Koblin’s website *The Sheep Market* ([2006](#b-9781474207935-015-0000113)) raised questions about automated production, collective intelligence and the value of labour and artistic production. Koblin used Amazon’s Mechanical Turk (MTurk) service, which was launched in 2005, and essentially provided an “interface” for using human intelligence to perform actions or solve problems that are not easily handled by a computer. People requesting services through the MTurk application (requesters) can pose Human Intelligence Tasks (HITs), which are then carried out by people who choose to complete them (workers or providers) for an amount of money determined by the requester. The service references a famous chess-playing automaton named Mechanical Turk, created by Wolfgang von Kempelen in the eighteenth century, that toured Europe and was enormously successful at beating its human opponents. Rather than being an early and advanced example of artificial intelligence, however, the Turk was a hoax, a chess player was hiding in a compartment of the automaton and controlling its operations. Koblin employed the MTurk service to request the execution of a simple task, “draw a sheep facing left,” for a payment of $0.02. The resulting 10,000 sheep drawings are exhibited at *The Sheep Market* website, collectively providing a rather humorous structural analysis of approaches to drawing a sheep. Koblin’s use of the MTurk application puts the work into the context of “creative labour” and raises more serious questions about the value of (artistic) cultural production. *The Sheep Market* deliberately makes no claims for participatory art: people are hired to perform a creative task for an extremely low wage and the artist, in one section of the website, provocatively sells blocks of sheep drawings for $20 as adhesive stamps with a certificate of authenticity, which generated heated online discussion. In a confrontational way and without taking an easy position, Koblin highlights the “exchange values” that are involved in cultural production and collective creation.

The early online performances in the graphic chat rooms of the 1990s found their continuation in works that used Massive Multiplayer Online Role-Playing Games (MMORPGs) and social media platforms such as Facebook and Twitter as performance spaces. In his performative intervention *dead-in-iraq* (2006–11), artist Joe DeLappe entered the online US Army recruiting game *America’s Army*, and manually typed in the name, age, service branch and date of death of each service person who had died in Iraq up to that date. The work is both a form of online memorial and reflection on the role of military games in contemporary culture. Continuing the type of performative experimentation used in *Desktop Theater*, *Dorm Daze* (2011) was a sitcom performance piece by British artist Ed Fornieles and his friends and acquaintances that unfolded on Facebook. Over the course of three months the artist and his friends impersonated fictional characters, supposedly a group of students at the University of California, Berkeley, and staged an improvised soap opera with multiple subplots via Facebook status updates. Feeding off the narcissism of social media culture and exploring conventions of story and identity, *Dorm Daze* both subverted the online platform and highlighted its narrative potential.

Two-dimensional graphic chat environments evolved into more complex 3D virtual worlds. Launched in 2003, Second Life (SL), an online virtual world developed and maintained by San Francisco–based Linden Research, Inc. (Linden Lab), emerged as one of the most successful virtual worlds to date and received international coverage in the mainstream media. A downloadable client program enables the users and residents of SL to inhabit and explore the world, build their homes and socialize making use of social networking services. Residents were also able to buy real estate and create and trade items, known as virtual property in the “in-world” currency of Linden dollars, which were traded for “real world” currency.

Virtual worlds such as Second Life offer a performative environment for both realizing what is not possible or at least difficult to achieve in the physical world and questioning the relationship between the virtual and physical realms. In their series of Reenactments (2007–10), Eva and Franco Mattes (aka 0100101110101101.org) made use of this opportunity by restaging famous performances—such as Marina Abramovic and Ulay’s *Imponderabilia* or Vito Acconci’s *Seedbed*—that were focused on embodiment, thereby underscoring the qualities of physicality and simulation. Like its graphic chat room predecessors, worlds such as SL provided the stage for public performances. Supposedly the first performance group operating in SL was Second Front, founded in 2006. In their works, Second Front have continuously engaged with the underlying “architecture” and economics of SL in often subversive and radical ways.

The critical and activist interventions of early net art, such as those by the Electronic Disturbance Theater, increasingly became more engaged with the corporate platforms on which they existed. Projects such as *Face to Facebook* ([2011](#b-9781474207935-015-0000089)) by Paolo Cirio and Alessandro Ludovico engaged with the legal and ethical aspects of Facebook as networked public space. For the project, the artists “scraped”**—**that is, automatically collected the data—of one million Facebook profiles, filtered them with face recognition software and then posted them on a custom-made dating website, sorted by the characteristics of their facial expressions. Cirio’s and Ludovico’s artistic activism explored the contested space of ownership rights to personal data from multiple perspectives. While no Facebook login was required to retrieve any of the profiles, the act of analysing and repurposing them led to multiple disputes. The *Face to Facebook* installation includes prints of the stolen faces, a local version of the Lovely Faces dating website, media coverage of the project, as well as exchanges between the lawyers for Facebook and the artists and reactions by the public. Ben Grosser’s *Facebook Demetricator* ([2012](#b-9781474207935-015-0000105)), by contrast, “deconstructs” the framework of Facebook: the project takes the form of a browser extension that can be installed by anyone and removes all metrics from the respective users’ Facebook pages, highlighting how much the appeal of the social media platform depends on the quantification of friends, liking and being liked. The aforementioned projects illustrate how the boundaries between the public and the private have been redrawn in the age of social media and networked platforms of data aggregation. What was once considered personal and private has become increasingly public in a cultural shift entailing a reformulation of our identity.

While projects such as *Face to* *Facebook* and *Facebook Demetricator* essentially use the same strategies and methods as protests and performances in public space, they sometimes directly disrupt or “rewrite” a commercial software environment. What enables this form of intervention is the openness of the digital architecture of many multi-user spaces, which are based upon the possibility of collaborative exchange and reorganization of space. It is the architecture of the digital public space itself that inherently allows for the reconfiguration of command/control modules and protocols.

## Post-Internet Art

The early teens of the twenty-first century brought about yet another shift for art on the web with the era of the so-called “post-internet art” that uses the internet in its production processes but often takes physical form. Whether one believes in the theoretical and art-historical value of the label “post-internet,” its popularity illustrated the need for a new terminology capturing not only a familiarity with the vernacular and functions of the internet, but the embeddedness of the digital in the objects, images and structures we encounter on a daily basis and the way we understand ourselves in relation to them.

What was once a clearly defined category of “net art” existing exclusively on the web increasingly became networked art that exists across media, incorporating online and physical components. Ceci Moss traces this rise of a multifaceted approach to online artistic practice in her book *Expanded Internet* *Art* ([Moss 2019](#b-9781474207935-015-0000120)), which explores how artists use various online and offline means to make art about informational culture and create a critical language in response to the persuasive influence of networked technologies.

Network technologies have become all-pervasive and, since 2005, in particular, the virtual territory of the internet, which has always been intertwined with the physical environment of servers and a complex cable network supporting it, has become increasingly embedded in physical structures. Networked mobile networks, the use of smart phones and tablets, and smart architectures ultimately brought forth the era of the post-internet.

The “expanded,” more hybrid internet art may still use social media platforms or the blockchain for audience participation but incorporate different media and presentation formats. Artist Rafaël Rozendaal, for example, has become known for pop-inspired, colourful and elegant websites—owing as much to the history of net art as Op Art or abstract painting—which he frequently refigures into physical versions, such as lenticular prints or projections on glass or sand. While the physical objects are inspired by and maintain the integrity of the websites’ visual effects, they also exist in a fundamentally different reality. For his Abstract Browsing series ([2014](#b-9781474207935-015-0000129)), Rozendaal created a plug-in for Google’s Chrome browser that is available to anyone online and will reduce the images and text on any website visited to coloured rectangles. The artist surfs the web every day using his plug-in and compiles thousands of screenshots, which he then narrows down to a small selection that he produces as physical tapestries. The tapestries are created at the Textile Museum in Tilsburg in the Netherlands, where Rozendaal’s screenshots are converted into a file for output by the weaving machine. Rozendaal’s project connects layers of machine abstraction, from the initial transformation of web pages, which exposes a composition optimized to grab our attention, to the tapestry referencing the roots of computing in the nineteenth-century weaving machines that automated the creation of patterns.

A different expression of the intersection between networked and offline media forms can be found in Eve Sussman’s *89 seconds Atomized* ([2018](#b-9781474207935-015-0000135)), which breaks down the final artist’s proof of the artist’s video *89 seconds at Alcazár* into 2,304 unique “atoms.” The atoms each consist of a unique 20 × 20 pixel video fragment of 9:44 minutes’ length and are sold to the audience/collectors on the blockchain, a digital ledger of transactions that stores data units or “tokens” distributed across the entire network of computer systems. Tokens can be fungible, meaning interchangeable, or non-fungible, certifying a digital asset to be unique and therefore not interchangeable. *89 seconds at Alcazár* experiments with collective ownership by allowing the piece to be reassembled and screened in the gallery space by a community of collectors and is one example of the so-called crypto art that emerged after 2014 and uses the blockchain as a conceptual element.

Non-fungible tokens (NFTs) gained prominence in 2021 as they were used by auction houses and online market platforms as a sales mechanism for digital images, some of them achieving record prices. NFTs ultimately are a digital form of a traditional certificate of authenticity and link to but do not actually include the image or artwork in question, which is a discrete file hosted on another server or can even be a traditional, physical work of art. While many images sold via NFTs are collectibles and not fine art or may not even be digital-born, artists have started to experiment with NFTs in more creative ways, using them to produce generative works or form decentralized autonomous organizations (DAOs) that use “social tokens” providing access rights to the online community.

## Conclusion

From its inception, art on and in the web has continuously engaged with the spaces of the network and reflected on their development. Early net art tended to be playful, exploring the participatory nature of the web, the configuration of information within browser environments and the performative potential of multi-user platforms. In the 2000s, blogs and social networking sites such as Facebook, YouTube, Twitter and Instagram—the next generation of web-based services known as Web 2.0—led to new expressions of artistic practice. Web 2.0 sites provide a hyperlinked broadcasting environment with meta-tags that allow for easy filtering. The networked commons of Web 2.0 includes platforms that help creative and cultural communities to stay informed and improve policies that shape cultural life. At the same time, the commercial construct of Web 2.0 creates a version of users as “content providers” who fill contextual interfaces with data and make their personal data subject to data mining. Artists began to critically investigate both the potential and the problematic aspects of the Web 2.0 landscape, using its commercial platforms for creating narratives and interventions.

Art about the web entered yet another phase with the post-internet era and the increasing embeddedness of networked technologies in physical space. The expanded internet art of the 2010s marked a return to materiality and integration of materials and networked processes. The web will continue to be an important platform for artistic practice and likely be more widely used by artists as the internet continues to permeate all aspects of daily life, commerce and culture.

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According to the *Oxford English Dictionary* the etymology of “network” goes back to the 1500s, when it was used to describe structures of lines and interstices giving the resemblance of a net. These early uses related to structures appearing in nature, in the tissues of animals and plants, as well as human-made materials or decorative patterns. In the early 1800s it started to be used to describe infrastructures such as railroads and transportation systems. This association with infrastructures continued alongside technological developments of telecommunications, electrical distribution, broadcasting, computing systems and the internet. The use of the term expanded in the late 1800s, when it was used to describe interconnected groups of people and organizations. While many of the infrastructures highlighted have been used to connect people it was emergence of the social networking sites in the late 1990s that arguably brought these two perspectives together and shifted the consideration of network from a topological structure to the more fluid notion of interdependent and independent relationships that are subject to continuous reconfiguration ([Coulton and Lindley 2019](#b-9781474207935-016-0000175)).

The rise of social networks also instigated a fetishization around the potential economic value of the data being produced in these social networks ([Zuboff 2019](#b-9781474207935-016-0000284)). Data was also a key component within the emergence of the so-called Internet of Things (IoT). The term “IoT” is attributed to a presentation given by Kevin Ashton in the late 1990s ([Sterling 2005](#b-9781474207935-016-0000273)). Ashton was a pioneer of the use of radio frequency identification (RFID) technology (and its subsequent evolution into near field communications (NFC)), and initially the IoT was primarily concerned with tracking items through time and space on their earthy sojourn ([Sterling 2005](#b-9781474207935-016-0000273)). Reflecting on what he originally discussed, Ashton’s thoughts are resonant with contemporary discourse around the IoT and in particular the potential for computers to autonomously collect, process, transmit and act upon data: “If we had computers that knew everything there was to know about things—using data they gathered without any help from us—we would be able to track and count everything, and greatly reduce waste, loss and cost” ([Ashton 2009](#b-9781474207935-016-0000161)). However, the IoT has evolved from the focus on tracking and is now much more associated with the notion of “smart” products and services sold under the promise of making our lives easier and more efficient—akin to Mark Weiser’s vision of “ubiquitous computing” ([1991](#b-9781474207935-016-0000276)). What is frequently absent from these discussions is consequences of the tsunami of data which is generated through our interactions as we add millions of IoT products and services to our networks. This additional data is often combined with data from our online activities in social networks and shopping allowing increasingly detailed profiles of us to be generated. Our ever-increasing entanglement within this Network of Things requires new ways of considering this space as well as offering potential new ways of creating and presenting media in this space, which is the primary focus of this article.

## What are the Things in the Network?

In order to address our entanglement within the network of things it is most useful to approach this through concrete examples and arguably the most accessible examples come from the IoT products and services targeting the consumer market, in particular those for use in our homes. These connected products are often referred to as “smart” and our IoT-enabled homes are often called “smart homes.” The promise of smart homes filled with connected products is frequently promoted as a way of making our lives easier and more convenient. For example, the Roomba© robotic vacuum cleaner claims to allow you to “Forget about vacuuming for weeks at a time and that it (the robot) is smart enough to know if your cat has tracked its litter through the house” ([Gradinar et al. 2019](#b-9781474207935-016-0000195)). While many consumers are increasingly conscious of the data they generate through social media use, they are generally less conscious of the data they generate elsewhere, such as while watching streaming media or online shopping. IoT products and services add to this largely unconscious data production and rarely make it clear to their owners the extent to which data is collected, where and how it is stored, and what it is being used for and by whom. While awareness of these human–data relationships may not be of immediate concern to many users, when this activity is unexpectedly brought to the fore they often challenge our existing expectations for personal privacy in our homes ([Akmal and Coulton 2018](#b-9781474207935-016-0000155)). For example, returning to the Roomba© vacuum cleaner discussed previously, many owners were shocked to learn that the latest versions of the device produced detailed maps of their homes, although this information was available in the small print of the terms and conditions ([Gradinar et al. 2019](#b-9781474207935-016-0000195)). These maps were then relayed to the manufacturer, who could potentially have shared these with third parties (though there is no evidence this ever occurred). While an automatic vacuum cleaner seems attractive, a digital device which maps the interior of your home in order to—potentially—distribute that map to unidentified third parties is clearly a more challenging proposition for most consumers. This example is not an isolated occurrence and is arguably a product of human-centred design (HCD) approaches being applied when making smart versions of existing products ([Coulton and Lindley 2019](#b-9781474207935-016-0000175)). Before we unpack this discussion around the design of networked things it is useful to consider some of the attributes of such things.

## Nature of Things

Under the rhetoric of innovation arguably many of the current IoT products and services being created are evidence of a design culture displaying a penchant for products that demonstrate what Evgeny Morozov describes as “solutionism,” as they frequently appear to be “solving problems that do not really exist” ([2013](#b-9781474207935-016-0000231)). For example, self-driving baby strollers, connected underwear, smart dental floss and connected showerheads are just a few of the hundreds of examples of IoT products and services that are largely superfluous to our lives and are notably documented through the X (formerly Twitter) account The Internet of Shit (@internetofshit). These devices are similar to what the science fiction author and technology critic Bruce Sterling describes in his 2005 non-fiction book *Shaping Things* as “Gizmos,” which primarily describes objects that offer some form of limited user programmability. Sterling characterizes classes of objects into their varying human–object relationships. These are:

* Artefact: made by hand, used by hand and powered by muscle.
* Machine: complex artefacts with integral moving parts and with a non-human/non-animal power source.
* Product: non-artisanal, uniformly mass-produced artefacts, supported by large transport, finance and information infrastructures.
* Gizmo: user alterable and programmable multi-functional objects commonly linked to network service providers.
* Spime: networked objects with extensive and rich informational support that are designed on screens, fabricated on screens and tracked in space and time throughout their life-span.
* Biot: is an entity that is both object and person that provides data to the network.

It has been argued that although these spimes are crucial to delivering an optimistic, sustainability-centric future which is enabled by the IoT, it is the gizmo that currently dominates ([Stead et al. 2019](#b-9781474207935-016-0000262); [Stead et al. 2020](#b-9781474207935-016-0000267)). Arguably, many of the IoT gizmos being developed for the home user are little more than disposable novelty devices. In addition to novelty, however, they are often part of what has been named “surveillance capitalism” ([Zuboff 2019](#b-9781474207935-016-0000284)), facilitating mass data collection for the purposes of corporate profit. The social platform Facebook is notorious for its highly effective targeted advertising, which tracks usage, not only on Facebook’s platform, but across vast swathes of the web as well. This type of data collection is based on the assumption that if something is described by a sufficient volume of data, then the certainty of a decision made based upon the data will be increased ([Morozov 2013](#b-9781474207935-016-0000231)). Because of this assumption, and because of the huge financial wealth generated by large corporations such as Facebook and Google through the collection of vast amounts of user data, IoT designers are often tempted to turn their gizmos into data collection devices and are producing vast data lakes within which data is stored in its raw format rather than managed in data warehouses. Whether this data turns out to be valuable or not remains to be seen (it is arguably likely that the complexity of human experience and social context will render much of it useless). It is also important to note how data collected now may have unintended consequences in the future. For example, fitbit collects your health data on a daily basis directly from your wrist; in a not-so-distant future, your health data could be used by insurance companies to increase your premiums based on your lack of physical activity. While this may seem far-fetched we have already seen insurance companies offering black box car insurance to learners and young drivers which requires the fitting of a telematics device to their vehicle to monitor their driving habits. While insurance is a common example of this extended use of data, in the future it could be relevant to what products you are offered, where you are allowed to live, what romantic opportunities are presented to you or the price at which retailers offer their products to you. In this sense while the products themselves are often superfluous, their potential effects on everyday life could be enormous. This proliferation of data is increasingly the subject and material for artists, for example Aaron Koblin, whose project *Flight Patterns* visualizes every airline flight over North America in a 24-hour period, and Nathalie Miebach, who transforms weather patterns into complex sculptures and musical scores. In terms of networked things, for the artwork *Red Pokey Sleep,* *2011* Laurie Frick used her nightly sleep data captured over a year using a Zeo, EEG sleep monitor; Superflux created the film *Uninvited Guests*, presenting an elderly man being monitored by smart utensils; and the Near Future Laboratory created the *TBD* [to be designed] *Catalog*, volume 9 issue 24, which presented a catalogue of future devices as if they could be purchased.

## Where the Wild Things Are

When we add networked capability to things we change the nature of the physical space by adding a digital overlay akin to what Anthony Dunne described as the “Electrosphere” in *Hertzian Tales* ([2008](#b-9781474207935-016-0000180)). One of the biggest challenges networked things pose is how they affect space and our expectations of those spaces, which requires us to unpack some of these concepts.

To consider our understanding of what we mean when discussing *space*, it is useful to draw upon the work of eminent geographer Yi-Fu Tuan, who described space as “an abstract term for a complex set of ideas” ([1977](#b-9781474207935-016-0000281): 6), which he says comes from how “people of different cultures differ in how they divide up their world, assign values to its parts, and measure them” (ibid.). In respect of networked things, of particular relevance when bringing these devices into our homes is consideration of inside and outside, as Tuan again highlights: “Consider the sense of an ‘inside’ and an ‘outside’, of intimacy and exposure, of private life and public space. People everywhere recognise these distinctions, but the awareness may be quite vague” (ibid.). The expectations one might have in regard to what interactions are appropriate within a public park will be very different to those happening in our own homes, as different qualities are associated with these *inside* and *outside* spaces. This consideration equally applies to our digital environments: with the “conceiving of cyberspace as a social space,” it can be seen as being “socially constructed, its meaning deriving from the uses to which it is put, and therefore capable of multiple simultaneous incarnations” ([Slane 2007](#b-9781474207935-016-0000257)).These incarnations of digital spaces become more convoluted when we become entangled within the heterogeneous network of things. A space can thus have multiple *spaces* associated with it and with each having its own meaning unique to those interacting with them at any given moment of time.

Returning to our discussion of spaces containing a sense of an “inside,” and an “outside,” we consider these in relation to two realities: one being the physical reality that we have around us which we physically interact in (Real Space), the other being a virtual one where interactions of digital objects exist (Digital Space). The idea of virtual being present alongside the physical has been discussed by moving from the delineation of space along a “Virtuality Continuum” ([Milgram, Takemura, Utsumi and Kishino 1995](#b-9781474207935-016-0000225)), to one where we predominantly live in a world where “both the real and the virtual coexist” ([Coulton 2017](#b-9781474207935-016-0000169)). This acknowledges that virtual worlds are also seen as literal places that “can be construed not just in terms of globalized online networks, but in terms of space, landscape, and localities as well” ([Rymarczuk and Derksen 2014](#b-9781474207935-016-0000246): 1).

The next step is to further understand these spaces with their insides and outsides—we can add other considerations such as the incorporation of private and public. These spaces often contain information that we physically and/or virtually interact with. For example, an online public message board can be considered analogous with a discussion in the park or town square where others may very well hear you; similarly a biometrically protected digital diary can be related with a physical key and lock diary. However, when real space and digital space overlap through networked objects, more complex entanglements result that can challenge existing expectations of what public and private may mean. For example, if you are having a private conversation at home with a friend but there is also an Amazon Alexa in the room, it may well be recording that conversation under the auspices of improving its functionality, and what was once considered a very private space has now become more public, which leaves the question of how we may unpack such entanglements.

In his essay “Des espaces autres” (Of Other Spaces) Foucault (1984) introduced the concept of the *heterotopia*, exploring how our lives are “governed by a certain number of oppositions that remain inviolable,” calling them “simple givens,” being “between family space and social space, between cultural space and useful space,” but, more importantly, “between private space and public space” (ibid.). He explains these as ideals that are “nurtured by the hidden presence of the sacred” and calls these heterotopias “placeless places” because of their deviation from the norm. He goes on to assert that “we do not live in a kind of void, inside of which we could place individual and thing,” rather, “we live inside a set of relations that delineates sites which are irreducible to one another and absolutely not superimposable on one another.” These other spaces thus exist as a “simultaneously mythic and real contestation of the space in which we live” (ibid.). For Foucault, ‘Heterotopias are places of Otherness, whose Otherness is established through a relationship of difference with other sites, such that their presence either provides an unsettling of spatial and social relations or an alternative representation of spatial and social relations’ ([Hetherington 1997](#b-9781474207935-016-0000201)). [Hetherington (1997)](#b-9781474207935-016-0000201) goes further on how these spaces are created, saying that they “bring together heterogeneous collections of unusual things”—the deviation from the norm—where they have no “order established through resemblance.” Furthermore, he discusses that what matters is the relationship seen “from the standpoint of another perspective, that allows a space to be seen as heterotopic.”

Although the concept of heterotopia has most commonly been used to define alternative physical spaces such as those referenced by Foucault himself—for example the cemetery, a festival or the library—it also is used to define more abstract structures as he explains with the “rug (being) a sort of garden that can move across space” (Foucault 1984). Another analogy he gives is of the boat, which he calls a “heterotopia par excellence.” Rymarczuk and Derksen paraphrase McKenzie Wark where he discusses how the boat “as a ‘placeless place’ applies to cyberspace as well, particularly when it is a network, linking terminals in different places and times into a unified environment.” They go further to propose how cyberspace can “as a whole be considered as a heterotopia, but within it there exist (further) heterotopias” ([2014](#b-9781474207935-016-0000246)).

Foucault established six principles to explain his ideology of a heterotopia ([Akmal and Coulton 2018](#b-9781474207935-016-0000155)):

1. All cultures display the ability to create, or have created, heterotopias though they exhibit a wide variety of forms depending on the relationship to the space they inhabit and the culture from which they emerge.
2. That heterotopias are not fixed and they can adopt novel functions or new meanings. Foucault provides the example of a cemetery having evolved over time to be “no longer the sacred and immortal heart of the city, but the other city, where each family possesses its dark resting place” ([Foucault [1967] 2008](#b-9781474207935-016-0000183)).
3. Heterotopias can simultaneously incorporate several spaces within a single real that in themselves seem incompatible. For example this would acknowledge that public and private spaces can coexist within a single space.
4. The fourth principle establishes the concept of *heterochronies*, being that “heterotopias are most often linked to slices in time,” forcing an “absolute break with traditional time”; cemeteries, museums, libraries are examples of “becom[ing] heterotopias in which time never stops building up and topping its own summit” (ibid.).
5. Heterotopias incorporate systems of opening and closing which can be imagined through metaphorical *gatekeepers* entrusted with responsibilities to allow certain things to enter and exit the heterotopia; digitally this can be imagined through payment, registration and identification protocols.
6. Finally, Foucault states heterotopias have “a function in relation to all the space that remains” around them and ‘unfolds between two extreme poles’, in a bid to “expose every real space,” through creating an alternative “space of illusion” (ibid.). Rymarczuk and Derksen describe this as defining a “space of perfection to compensate for the flaws of real life” ([2014](#b-9781474207935-016-0000246): 2).

These principles of heterotopia were utilized by Akmal and Coulton to help in the consideration of how networked things simultaneously exist in real (physical) space and digital space and create further spaces.

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[Figure 16.1](#b-9781474207935-016-0000052) shows their proposed heterotopical spatial model ([Akmal and Coulton 2018](#b-9781474207935-016-0000155)), incorporating Foucault’s principle and the notion of a mirror as a parallel space which he describes as a *utopia* since you see yourself where you are not; or as he expresses it, “in an unreal, virtual space that opens up behind the surface” ([1967] 2008)—here the seeing of oneself is taken in the sense of the actant in a space, so a mobile phone or networked thing could be imagined similarly.

The mirror functions as a heterotopia in this respect: it makes this place that I occupy at the moment when I look at myself in the glass at once absolutely real, connected with all the space that surrounds it, and absolutely unreal, since in order to be perceived it has to pass through this virtual point which is over there.

— ([Foucault [1967] 2008](#b-9781474207935-016-0000183))

The model thus incorporates two spaces (the real and the digital) coexisting as one within the other, each with its rules and regulations and encompassing individual spheres of privacy and publicity. Further overlaps are seen between the real and virtual iterations of privacy and publicity and they form the more unique and albeit complex heterotopias. Akmal and Coulton suggested that these different spatial configurations allow designers to better interrogate and understand the way networked objects can affect our interactions when introduced into our lived environment ([Akmal and Coulton 2018](#b-9781474207935-016-0000155)). This model also helps us understand that the media produced using networked things dramatically changes the space in which it may be viewed.

## Interdependent and Independent Things

To explore the complexity resulting from cohabiting with networked things let us consider it through the mundane example of a thermostat controlling our home heating, shown in [Figure 16.2](#b-9781474207935-016-0000065).

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The left side represents a traditional non-smart thermostat connected to the heating boiler (either wired or wirelessly) and providing the basic functions of timing and temperature control. While the user likely has a mental model such that the thermostat connects to the boiler, from an HCD perspective the focus is the interaction between the user and the thermostat and the relationship with the boiler would not be explicitly highlighted as this is not directly pertinent to the task of adjusting the temperature. While the boiler and the user could be considered to have both independent relationships with the thermostat and an interdependent relationship facilitated by the thermostat in reality the HCD approach has “black boxed” ([Latour 1999](#b-9781474207935-016-0000204)) the thermostat in that its inner workings are hidden and only its interaction for the user is presented. Even though a “smart” thermostat, shown on the right of [Figure 16.2](#b-9781474207935-016-0000065), might offer advanced features such as remote control, learning through occupancy patterns, etc., in terms of HCD the main consideration remains interaction between the user and the thermostat; and while the users’ mental model of how it integrates to the heating system is likely based on their previous understanding, the reality is much more complex. [Figure 16.3](#b-9781474207935-016-0000071) represents a possible ontography (an artefact that reveals the existence and relation of objects ([Bogost 2012](#b-9781474207935-016-0000166))) of our smart thermostat and highlights some of the interdependent relationships between things in the network. The “thing” in this particular consideration derives from the philosophy of object-oriented ontology ([Harman 2018](#b-9781474207935-016-0000198)) and is used to describe any self-contained construct: for example, a thermostat, a person, data, an algorithm—in other words both physical things and conceptual things ([Coulton and Lindley 2019](#b-9781474207935-016-0000175)). While the interdependent relationships help illuminate the complexity introduced when a smart device replaces a not-networked device, the independent perspectives allow for greater consideration of what data is being collected, how it is being used and by whom.

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Explorations of such interdependencies are being undertaken in various forms of artistic work, for example the *Anatomy of AI* project by New York University’s Kate Crawford and University of Novi Sad’s Vladan Joler. This project is effectively an ontography in the form of a large-scale map and essay investigating the human labour, data and planetary resources required to manufacture and operate an Amazon Echo. Works that explore differing perspectives existing within a network of things include Superflux’s examination of the agency of non-human things in *Our Friends Electric* ([Rogers et al. 2019](#b-9781474207935-016-0000240)) and the film *Ghosts in the Smart Home*, which presents a form of soap opera in which the characters are interconnected smart devices ([Lindley, Gradinar and Coulton 2020](#b-9781474207935-016-0000216)).

## Smart Networked Things?

Whenever we use the term “smart” we inevitably get into a discussion around artificial intelligence (AI), which subsequently reveals a big disparity between the public perception of AI and how they might actually experience AI, and it is the inescapable link between science fiction and AI that fuels this disparity. Popular visions of AI show machines with a human-level general intelligence (i.e. with the ability to learn how to do different tasks). *The Matrix*, *Blade Runner* and *2001: A Space Odyssey*—these works of fiction depict what scientists and engineers would refer to as “strong AI” and artificial general intelligence (AGI), leaving a residual influence that overshadows the public’s likely everyday experience of so-called “weak AI” through systems incorporating facial recognition, natural language processing and recommendation services. While these everyday systems do “learn” how to do specific tasks very well indeed, they do not have the general intelligence necessary to reskill themselves, or to spontaneously learn without configuration—as those shown in science fiction tend to. The conceptual space between the entirely fictional (but highly influential) science fiction visions of AI and the very real (but quite mundane) applications of AI is referred to as AI’s *Definitional Dualism* ([Lindley, Akbal, Pilling and Coulton 2020](#b-9781474207935-016-0000207)). This dualism, demonstrated in [Figure 16.4](#b-9781474207935-016-0000081), can act to stifle progress about the issues to hand because, as Lindley’s Law states, “any sufficiently in-depth conversation about ‘AI’ will result in the dialogue becoming about sentient killer robots” ([Lindley and Coulton 2020](#b-9781474207935-016-0000213)).

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The murkiness and ambiguity arising from AI’s Definitional Dualism is also, arguably, what provides the rhetorical backdrop to allow for some networked products and services to describe themselves as using AI, when in fact they do not, which has been described as “AI snake oil” by Anab Jain, one of the co-founders of Superflux ([Lindley and Coulton 2020](#b-9781474207935-016-0000213)).

The current period of excitement around AI is not being driven by any major advances in the theory and science behind AI approaches but rather by the increased availability of large datasets (often generated through our interactions) and the abundance of cheap computing power, which networked objects both produce and take advantage of. Computing power and data are the resources necessary to operationalize and exploit *machine learning* (ML) and *deep learning* (DL) techniques, both of which employ so-called *neural networks*.

Although the terms “AI” and “ML” are often used interchangeably, ML is a subset of AI, and the potential applications of ML represent much of the promise currently giving rise to the excitement around the possibilities of AI. ML works by creating data to train models. These models may be utilized to make predictions (e.g. guessing what word will be typed next when a keyboard is in use) or to generate new data (e.g. creating a life-like but artificial photograph of a human).

ML usually relies on labelled training data. For example, we may take a collection of photographs of artworks. The data is structured so that images which contain the works by Picasso (for example) are labelled as such. Then, using a classifying neural network, the structured data (combination of images and labels) is processed and the result is a usable model. Such models—assuming the training data was appropriate, the labelling was accurate, the neural network was configured correctly—accurately determine whether new images (i.e. those it has never seen before) could be by Picasso. The same process can be applied to many different tasks.

While ML is a data-driven subset of AI, DL, in turn, is a subset of ML. The key difference between ML and DL is that rather than relying on labelled datasets to provide the structure of the data, multiple layers of neural networks manage to extract features automatically and thus create a nested hierarchy of concepts or abstractions of the source data. While an ML system relies on humans to extract the features (or rules) of classification, in DL the system creates its own rules and tests them internally. The distinction between ML and DL systems is sometimes referred to as “supervised” (ML) and “unsupervised” learning (DL).

The relationship of networked objects to data collection is a fundamental one whether they specifically use ML or DL or not.

While ML is being used in an array of artworks it is predominantly used in a generative fashion as in such works as *The Portrait of Edmond de Belamy*, which effectively is an amalgamation of common elements from portrait images (i.e. facial features); or in such works as *The Faceless Portrait of a Merchant* by Ahmed Elgammal, which appears to be a selected image from the latent space of the trained model (latent space refers to space created by the ML that contains feature values encoded from its training which it uses to generate future images). In terms of media produced in response to the functioning of networked smart objects there are fewer examples, but associated work includes, for example, that of Sougwen Chung, who collaborates with robots, or the project *Hello Lam Post*, which simulates intelligent street furniture through Mechanical Turks (humans performing discrete on-demand tasks that computers are currently unable to do).

## Networked Media Things

The previous sections presented an expanded notion of what constitutes the things (objects) within the network beyond mere physical things. In this section we further expand this in relation to media creation through a discussion of Object-Based Media (OBM). OBM is a concept proposed by the British Broadcasting Corporation’s Research and Development team (BBC R&D) to enable their vision of delivering broadcast media that is personalized, adaptable, dynamic and responsive in order to create new forms of immersive experiences ([Gradinar et al. 2019](#b-9781474207935-016-0000195)). OBM considers all different parts of the media as objects: for example, video sequences, sound effects, music tracks, sign-language overlays and subtitles. By encoding the semantic relationships between these objects, OBM can reconfigure and customize content depending on the audience and context. Examples of how OBM could be used include abridged catch-up versions of soap operas allowing viewers to catch up on several missed shows in a short amount of time without losing any of the salient events; dynamic sound mixing to make content more accessible to those who are hard of hearing; content automatically targeted to viewers based on preference (e.g. for fans of a sports team, or a specific band). The key aspect of OBM for the BBC is that it can be used for broadcast media rather than being seen as a means of producing interactive media. To illustrate this difference, consider [Figure 16.5](#b-9781474207935-016-0000097), which contrasts broadcast OBM with interactive storytelling.

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Interactive storytelling can be considered as branching narratives which involve audiences making choices to navigate a pre-defined narrative as per the 2018 Black Mirror film *Bandersnatch* or the choose your own adventure books (the link between the two in fact became the subject of litigation in the US in that the publisher sued the filmmakers). Perceptive Media broadcast OBM, in contrast to interactive storytelling, which relies on audiences to influence a storyline through direct action, utilizes contextual information relevant to audiences and data gathered using a range of sensors to subtly alter the media. Although the overall story arc remains the same for each viewer, ambient aspects of the narrative adjust the way digital media is presented in order to create a more engaging, context-specific experience for the audience ([Gradinar et al. 2015](#b-9781474207935-016-0000189)). Further, this also represents a conceptual shift away from, say, a transient liminal experience of immersion enabled by hot media like virtual reality (VR)—or media produced to dominate a single sense such as described by McLuhan ([McLuhan and McLuhan 1994](#b-9781474207935-016-0000222))—to a cooler liminoid experience which engages multiple senses through broadcast OBM. Put another way, rather than facilitating transfer between entirely separate real and virtual contexts OBM aims to unite both contexts together, to be experienced at once. The aspiration is that such liminoid experiences can, through this contextual unification, provide media experiences that are immersive but significantly cooler and more inclusive as indicated in [Figure 16.6](#b-9781474207935-016-0000103).

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To demonstrate this concept in practice BBC R&D, along with Lancaster University and Nottingham University, built an experiential prototype the *Living Room of the Future* (LRofTF) designed to resemble a typical UK living room since this is a universally understood space within our own homes that those participating in the experience would be familiar with. While the initial version of the LRofTF was designed as part of a public exhibition for a specific installation in the FACT gallery in Liverpool (UK) ([Sailaja et al. 2019](#b-9781474207935-016-0000251)), it was subsequently redesigned with new interactions and a new narrative for events at the Victoria and Albert Museum and the Tate Modern in London before going on permanent display in a “Future Home” at the Building Research Establishment in Watford ([Gradinar et al. 2019](#b-9781474207935-016-0000195)). You can see what the LRofTF looks like in the images shown in [Figure 16.7](#b-9781474207935-016-0000109), and it is this version that will be used to illustrate the concept in this discussion.

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The following sections take into consideration the design decisions that went into the experience created by looking at the relations of the three types of objects previously described: physical, media and data as shown in [Figure 16.8](#b-9781474207935-016-0000115).

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## Physical Objects

The LRofTF was designed to represent a potential near future and thus included a selection of off-the-shelf IoT products, which included programmable lights, a heating/cooling fan, window blinds and smart plugs. In addition to these commercially available products, other bespoke devices were create which included: a clock-radio whose speaker provides ambient sounds as part of the media; a series of sensors to detect audience interactions with objects in the room (including a drink coaster and a remote-control device); a coffee table with in-built hand sensor, display and thermal printer; and a voice-activated LED “eye” which provides a personality for the living room and acts as the camera for its face-scanning technology. While the commercial products and the printer may be considered as “outputs” of the LRofTF, the sensors should be seen as “inputs” that generate data the system then uses to personalize the experience.

## Media Objects

The described version of the LRofTF uses a short drama called *The Break-Up*, specially commissioned by the BBC R&D to highlight the potential of dynamic programming for television. *The Break Up* is a special type of programme which utilizes “Perceptive Media,” which had previously only been demonstrated for radio ([Gradinar et al. 2015](#b-9781474207935-016-0000189)). *The Break Up* was written and filmed in such a way that the entire narrative can be shifted to accommodate the viewer. For example, there are two contrasting endings (one which might be perceived as positive and one that might be perceived as negative) and two paths through the story (one emphasizing the male character, and one highlighting the female). There is even an alternative version of the story where the gender roles of the characters are swapped, and rather than existing in the present day it takes place in a science fiction alternative universe. Further, it allows for dynamic changes of the soundtrack to better reflect the experience. By breaking the media into its constituent “objects” the LRofTF can utilize the OBM system to provide a personalized and unique experience to each viewer.

## Data Objects

The media objects of the film can be reconfigured based on data objects. This means that the system can construct different versions of the programme based on data which provides contextual information about the viewer and the environmental conditions. For example, data points such as the current weather, the location, time, number of people in the room, music preferences, political leanings can all be used as data inputs. These data points are combined with further information from the IoT sensors in the room (e.g. whether the audience is smiling, if they are looking away from the screen or whether they are moving around in their seats). Combined together—and processed by the OBM system—these data are used to deliver a completely personalized version of the film which is optimized to increase immersion.

## Addressing the Privacy Elephant in the Room

In order to address the privacy challenges of the experience (which acted as if it accessed various kinds of highly personal data) all data moving through the system was managed through a Databox providing a unique ecology for exploiting personal data in privacy-preserving ways. For example, Databox can enable a media provider to utilize algorithms that process data referring to an individual’s viewing habits in order to offer bespoke content, but can do so *without* disclosing personal data directly to the provider. Instead of distributing personal data to remote cloud servers for processing, processing takes place on-the-box (generally referred to as “edge computing”), preserving privacy by ensuring no personal data needs to leave the home or be accessed remotely ([Mortier et al. 2016](#b-9781474207935-016-0000234)).

## Lroftf Experience

The experience of the LRofTF can be considered as consisting of three acts. To begin, the participants seat themselves on the sofa in front of the television screen. The experience is then introduced using a voice user interface (whose persona is the room itself) which seeks to gain consent from users to collect, process and store their data. At the end of this negotiation the LRofTF prints out a permission slip using the thermal printer embedded in the coffee table, which the audience must sign to proceed otherwise the voice expresses its disappointment and requests they exit through the gift shop. In the second act of the experience a particular version of *The Break-Up* is played based on a profile generated by the system during the negotiation in act one. During this phase various IoT objects in the room begin to contribute to the immersion. For example, at the start of the film the blinds come down and the room’s lighting darkens before subsequently adapting to each scene (the system “knows” the outside weather and picks up a relevant colour gradient which is also applied to the film). When the lead character in the film is outdoors, the fan switches on, matching the wind blowing her hair. The music within the film is chosen dependent on the user profile generated by the system, as is the chosen ending (which depicts the character either leaving or staying with her partner). In the middle of the story, if the audience appear bored (based on sensory inputs) an IoT smart plug is triggered by OBM to turn on an ultraviolet (UV) light during which a short section of the science fiction version of *The Break-Up* is shown before returning to the main drama. It is important to note that the impact of particular data interactions which affect the drama do not immediately affect the media objects, which means that while each experience is uniquely tailored to the audience, they would not necessarily be able to see why or how particular data affects the film at any moment in time. Therefore, in the experience the display in the coffee table highlights when data is being collected and subsequently used. Finally, as the audience has only experienced one of the many possible variations of the drama an explainer video shows the variations which could have occurred, and why, as shown in [Figure 16.9](#b-9781474207935-016-0000140). At the end, the system generates a receipt for the audience for the data generated. We do this as part of the experience to further highlight the transactional nature of the majority of personal data collection, in that we are trading system functionality for the participants’ data.

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## Conclusion

Within this article we have discussed the Network of Things primarily in relation to the so-called Internet of Things, and what hopefully has become apparent is that it cannot be represented, or defined, by a single technology but rather it is an assemblage of technologies and services that essentially operate through the internet. The majority of these networked things aim to provide enhanced or more efficient services to support our everyday lives. These enhancements are offered in a transactional agreement and are dependent on the collection of user-generated data and in effect although you may have purchased the networked object its continued functional availability is linked to the availability of data infrastructures and the continued production of data. While many of these networked things are described as smart this is primarily related to using ML in a predictive sense to anticipate future user behaviour and often to target users for advertising. The potential of this data to be used generatively using concepts such as OBM is currently underexplored and is lagging behind the renaissance of generative computing for creating visual artworks. It is worth noting that such media would also require fundamental changes in how it is conceived and produced and thus will require significant investment by content producers.

As discussed the data produced by these networked things can profoundly change the nature of the spaces in which it is performed particularly in relation to our expectations of the public and private. Thus while these devices offer a range of opportunities for media production to augment another media experience, to potentially enhance immersion, as demonstrated in the *Living Room of the Future* whereby they effectively become additional performers, they also present challenges as to how audience data is managed and stored in a way that addresses the very real privacy concerns.

Overall the use of networked things to create new forms of media delivery and production offers exciting opportunities and challenges but will require new ways of thinking about what these things are, what they do and how they can be used.

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# Section II: Theories

Coldly floweth all deep knowledge. Ice-cold are the innermost wells of the spirit: a refreshment to hot hands and handlers.

— Friedrich Nietzsche ([2012](#b-9781474207935-017-0000190): 141)

## The Largest “International Dark Sky Reserve” on Planet Earth

In the remote regions of far west Texas and northern Mexico, “Dark Skies” activists created the “Greater Big Bend International Dark Sky Reserve”—the largest International Dark Sky Reserve on Planet Earth. Officially approved by the International Dark-Sky Association in 2022, the Big Bend Dark Sky Reserve spans approximately 39,000 square kilometres of Texas and Mexico ([Karas 2022](#b-9781474207935-017-0000169)). That’s almost the size of Vermont, Connecticut and Rhode Island, collectively.

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This is the largest single area combatting the many effects of light pollution from the metropolis, big city or small town, all ever more aglow in electric light. The glow of electric light permeates our existence, from the skyglow of our cities to the screenglow on our phones, tablets, laptops and computers—key sights for the creation and experience of much new media art. Could it be that another kind of new media art is emerging as counter to the skyglow and screenglow, a new form of an ancient art, a form known as *Earthworks*. Perhaps the preservation of dark skies is a necessary corollary to Earthworks, suggesting a larger pattern, a *big bend* in the narratives for the human species, a chilly bend born of *cool media* and a new *new media art.*

## The Big Bend vs Skyglow

The “Big Bend” region is named for the big bend in the Rio Grande, the river which serves as the border between Texas and Mexico. The light pollution threatens the dark skies essential to the Big Bend National Park, the Big Bend Ranch State Park and the University of Texas’s McDonald Observatory (no connection to McDonald’s hamburger chain). The Big Bend National Park is one of the largest and most spectacular national parks in the world, spanning 324,000 hectares in the Chihuahuan desert ecosystem. In 1976, UNESCO designated the park as a Biosphere Reserve, making it one of the first and largest parks to receive this designation. Already designated as “Dark Sky Parks” by the International Dark-Sky Association (IDA), the two Big Bend parks are central to the International Dark Sky Preserve. Along with the three protected nature areas in Mexico, this reserve protects diverse and beautiful ecosystems, home to species found nowhere else on Earth.

Owned and operated by the University of Texas at Austin, the McDonald Observatory is one of the premier astronomical facilities in the world and home to the Hobby-

Eberly Telescope, currently the fourth largest optical telescope in the world. Many kinds of astronomical research are conducted at the facility, including studying the expansion rate of the universe effected by dark energy and searching for habitable exoplanets orbiting nearby stars. So why the need for a massive international dark sky reserve? Consider [Figure 17.2](#b-9781474207935-017-0000022).

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The bright yellow and green colours are not skyglow from a massive metropolis. Rather, the bright lights are from the massive sprawl of fracking fields in the beautiful desert expanse. Those lights span almost 26,000 square kilometres and help provide the fossil fuel power for electric civilization and the 24/7 media spectacle that spans the planet. The fracking fields provide the juice for our cities, homes, media networks and electronic screens.

According to a recent study of light pollution, 99 percent of Europeans and Americans live under heavily light-polluted skies, such that 80 percent of Americans can’t even see the Milky Way. Around the world, almost 80 percent of humanity lives under light-polluted skies and the skyglow is spreading ([Donahue 2016](#b-9781474207935-017-0000145); [Gholipour 2018](#b-9781474207935-017-0000148)). Given these totals and trends, it’s not hard to imagine a near future in which almost everyone will never see the Milky Way with their own eyes.

Skyglow is complemented by screenglow, for inside our electrified bubbles we park ourselves in front of an array of electronic screens, light pouring forth and bathing our eyes in the antics and drama of the human species, including many of its arts—traditional and new media. Of course, this issue may seem irrelevant to the more than 90 percent of humanity now living their entire lives inside an artificially illuminated existence, where nature is shoved aside and the night skies are erased from consciousness. Add on the screenglow of our electronic media, and it is clear that living in a perpetual electric glow is now the dominant state of existence for humanity. Skyglow and screenglow reinforce the existential narcissism of the human species, which is dominated by theist and consumerist worldviews that place us—individually and collectively—at the centre of everything, the centre of all meaning, all value, all purpose.

Apple got it right—iPod, iPad, iPhone, as in I am the centre of the universe. The same is true for Samsung Galaxy, a media universe that orbits around each of us, bringing all events through our screens, glowing in our eyes and on our faces. It is this techno-existential narcissism that is dramatically countered by dark skies, cool media and Earthworks.

## Dark Skies, Cool Media and Earthworks as New Media Art

Embedded in the International Dark Sky movement is an entirely new stance for technological civilization. If the Milky Way and dark skies could be returned to human consciousness on a regular basis or become easily accessible in national parks and dark sky reserves, then this might help inspire the development of a planetary system of values and a new cosmic narrative for our species. The Greater Big Bend International Dark Sky Reserve brings together nature and science, ecology and cosmology, and peaceful cooperation along a contentious border—all quietly pointing towards a new transborder narrative and a new philosophy for the human species.

The Big Bend Sky Reserve and protecting dark skies are also in synch with the emergence and evolution of Earthworks (also known as land art), especially the monumental Earthworks in the deserts of the American Southwest. The most famous of these Earthworks are *Double Negative* (Michael Heizer, 1969), *Spiral Jetty* (Robert [Smithson, 1970](#b-9781474207935-017-0000202)), *Sun Tunnels* (Nancy Holt, 1976), *Star Axis* (Charles Ross, 1973—nearing completion now) and *Roden Crater* (James Turrell, 1979—nearing completion also). All of these can be viewed in the daylight hours, but are best experienced at night, beneath dark, starry skies. But, to think of these as only Earthworks is to understate their power and existential significance, for they are also forms of cool media. By “cool media,” we do not mean McLuhan’s outdated version from the 1960s, but rather a twenty-first-century model that accounts for massive telescopes and monumental Earthworks ([Hildebrand and Vacker 2018](#b-9781474207935-017-0000154)). Given all the above, we can think of the Earthworks as new media art, specifically emerging in the 1960s and 1970s as a reaction to the commodification of art in the gallery system, but also as a response to the space age and the rise of television (and the early proliferation of screens).

This may seem strange, considering that new media art is typically understood as based in digital and electronic media. These include categories such as virtual art, computer graphics, computer animation, digital art, interactive art, sound art, internet art, video games, cyborg art (cybernetic implants), robotic art and 3D printing. Obviously, this list is not exhaustive and is only to illustrate typical categories of new media art, most of which are viewed on a screen, in a soundscape, in a multi-sensory room or inside a VR headset. This article argues that Earthworks are a form of new media art—a merger of ancient and contemporary art, along with contemporary cool media technologies (such as massive telescopes and naked-eye observatories). These technologies would be impossible without powerful computers, as would be the creation and construction of the apertures of *Star Axis* and *Roden Crater*.

The Big Bend Dark Sky Reserve, the McDonald Observatory and monumental Earthworks are deeply connected with a new philosophical outlook. What are the connections? Let’s just say they are deep, broad, chilly and strongly suggest an expansion of how we think about new media art, especially its relation to science, ecology and our place in the Nietzschean abyss that is the NASA universe. Surely, not all new media art must be experienced in a gallery or on a screen. This article is about the direction and temperature of the gaze, with massive art and media technology directing our view away from our hot selves and screens, deep into the starry skies and the chilly universe. In these desert galleries, framed with distant walls of vistas and ceilings of dark skies, the Earthworks are surrounded and visually isolated by vast *negative* spaces—realms perfect for immersion in nature, the cosmos and the sublime.

Of course, these panoramas are threatened by expanding skyglow and light pollution. And there’s another problem. This one philosophical and existential: the Nietzschean abyss that is the vast universe unveiled by cool media and contemporary astronomy. It is here that cool media and Earthworks possess their greatest power, in the momentary unity of the infinite and infinitesimal, in the sublime tightrope transcending the abyss.

## “A Rope Over an Abyss”

In *Thus Spoke Zarathustra*, Nietzsche explores the death of God, the eternal recurrence (the endless recycling of world events) and the possible rise of the “Overman.” Nietzsche speculates that since humans are the superior species that evolved from apes, there might be an equally greater species that would evolve from humans—what he termed the *Ubermensch* or Superman: “What is the ape to man? A laughing-stock, a thing of shame. And just the same shall man be to the Superman: a laughing-stock, a thing of shame” ([Nietzsche 2012](#b-9781474207935-017-0000190): 26).

Nietzsche suggested the next stage of human evolution could occur if we accepted our place on Earth—in the material world—rather than looking to otherworldly gods for meaning and purpose. Writing in the wake of Newton, Darwin and the birth of technological civilization, Nietzsche knew that the death of God presented a huge philosophical challenge for the human species: “man is a rope stretched between the animal and the Superman—a rope over an abyss” (ibid.: 28).

Nietzsche’s Ubermensch was meant to symbolically replace the decaying mythos of an omnipotent God, which humanity had created to ease the suffering of a meaningless existence. Employing the ethos of scientific and technological progress, this “theoretical” future human would deny the divine impulse, instead choosing to *understand* and *create* the ineffable value of existence. In the universe of Newton and Darwin, this future human pursues the sublime phenomenology in the aesthetics of awe and wonder, stolidly peering into the voids of eternity, gazing backwards into each future which altered the past. Sensing this new universe would be unbearable for humanity, Nietzsche muses “You are no eagles: so neither do you know the spirit’s joy in its terror. And he who is not a bird shall not make his home above abysses” ([Nietzsche 1956](#b-9781474207935-017-0000184): 125). This was prophetically the case in the duality between Apollo 8 and Apollo 11—when “the Eagle has landed.”

In the 1920s, Edwin Hubble expanded Nietzsche’s abyss with the twofold discovery of *other galaxies* outside the Milky Way and the expanding universe in which the galaxies are moving away from each other. Since then, the Hubble Space Telescope and other telescopes have revealed an epic universe of two trillion galaxies stretching across 100 billion light years. Nietzsche’s abyss has only grown exponentially, and nothing symbolizes the abyss better than the “Hubble Deep Field” images, produced when the Hubble Telescope peers into empty spaces in the night sky and finds thousands of galaxies located billions of light years away from Earth. The universe of Hubble and the Hubble Telescope—that’s the abyss over which we have yet to weave the needed philosophical and existential rope, even in the wake of Apollo—the first god of NASA.

## Apollo and the Black Monolith: Inspiring the First Earthworks

While Earthworks have roots in ancient megaliths that are found all around the planet ([Mohen 1999](#b-9781474207935-017-0000178)), their contemporary origins reside in icons of the Space Age. It is no surprise that the monumental Earthworks follow the Apollo moon landing (1969) and *2001: A Space Odyssey* (1968). Media theorist Marshall McLuhan asserted that seeing Earth from space converted our planet into a work of art to be modelled and controlled. We can add that Earth amid the vast negative space provided existential inspiration for artworks in the desert, surrounded by the negative space of vast landscapes and dark skies.

Prior to the Hubble images, Nietzsche’s abyss was first televised around the world when Apollo 8 and Apollo 11 went to the moon. Bill Anders, one of the Apollo 8 astronauts, took the famed photograph known as *Earthrise*. The version of *Earthrise* released by NASA does not represent the true orientation of the original image. Anders’s shot featured Earth *next* to the moon, not *above* it. It is not surprising that everyone, including NASA, preferred the version that was flipped on its side so that the blue and white Earth seemed to be “rising” above the moon’s grey horizon. Earth rising *above* the moon is much more comforting, providing the cognitive warmth of a morning sunrise. By contrast, Earth floating *beside* the moon with nothing above or below it is visually vertiginous.

This existential cop-out seems to express Nietzsche’s suggestion that we humans “are no eagles.” It’s no surprise, then, that the Apollo 8 astronauts soon read the more comforting, opening lines of Genesis to one billion people watching on television on Planet Earth. In effect, Apollo 8 orbited the moon, but clipped its own wings, philosophically crashing back to Planet Earth ([Vacker 2017](#b-9781474207935-017-0000205): 15–21). The view of Earth was just too cool, too chilly for the “hot hands and handlers” on Earth. NASA’s flipping of Earth proved McLuhan correct, for NASA’s goal was to control the view of Earth in space so as to control the philosophical narrative on Earth.

Apollo 11 momentarily corrected this trajectory when “the Eagle” (the lunar module) landed on the moon in the summer of 1969. As the first human stepping onto another celestial body, Neil Armstrong famously said: “That’s one small step for a man, one giant leap for mankind.” Watching Apollo 11 on TV, one billion people cheered and gazed with awe and wonder, instinctually yearning for a new beginning, a new era, a new destiny, all requiring a new philosophy. Six decades later, that era and secular philosophy has yet to arrive, at least in any large-scale way in popular culture.

Though *2001* pointed the way, its vision has been utterly overtaken in pop culture by the endless *Star Wars* sagas. In the meantime, perhaps inspired by the black monolith, Earthworks are inspiring us to steer our gaze in the direction of *2001*’s vision.

*2001: A Space Odyssey* is Stanley Kubrick’s masterpiece of space philosophy amid the Nietzschean abyss. In *2001*, Kubrick depicts a past and future in which humans have evolved from apes to astronauts via science and technology, along with an assist from a mysterious black monolith—all primed to propel an enlightened species into a massive and majestic universe in which we are not alone. Early in the film, a tall and sleek black monolith appears in the middle of the night. An ape is awakened and glances up at the sky. Soon tribes of apes are gazing upon the monolith, at first in terror and then seemingly with wonder and reverence. After shrieking wildly for a few moments, the apes gather around the monolith, touching it gingerly and eventually caressing it with affection. The monolith inspires a tribe of apes to invent technology and give birth to the evolution of the human species. In one key scene, an ape hurls a bone (used as technology to kill animals for food) high in the air, and just after the bone peaks in its ascent, the scene cuts to a spacecraft orbiting Earth against the black void of space. The cut from the bone to the spacecraft captures in a single moment and in a single thought the entire trajectory of human technological evolution, from the Stone Age to the Space Age.

Across the plot trajectory of *2001*, it’s clear that the black monolith comes to symbolize a blank slate for writing a new narrative for the human species. Is this monolith not a symbolic version of Nietzsche’s rope across the abyss?

Is the black monolith not also a work of fictional land art? Standing alone in the desert, surrounded by empty spaces, the monolith inspired the apes to look to the skies for their destiny. Looking to the skies and contemplating our destiny is the specific goal of monumental Earthworks like *Spiral Jetty*, *Sun Tunnels*, *Star Axis* and *Roden Crater*, set all alone in remote territories of the America desert. Just as the Star-Child in *2001* and Neil Armstrong in Apollo 11 momentarily flew above the chilly abyss, artists on Earth began to represent that abyss on Earth. And that art is speaking the cool.

## Hot and Cool Media in the Twenty-First Century

In *Thus Spoke Zarathustra*, Nietzsche observes “Coldly floweth all deep knowledge. Ice-cold are the innermost wells of the spirit: a refreshment to hot hands and handlers” ([Nietzsche 2012](#b-9781474207935-017-0000190): 141). Nietzsche was on to something that is clearly evident in twenty-first century media technologies. Inspired by contemporary cosmology, NASA, Nietzsche and Marshall McLuhan, Julia Hildebrand and Barry Vacker crafted a twenty-first century media theory, a single theory both sleek and spacious—a theory that encompasses our ways of seeing with media technology, including art ([Hildebrand and Vacker 2018](#b-9781474207935-017-0000154)). With a combination of theory and aesthetics, the essay won the John Culkin Award for Praxis, an international award from the Media Ecology Association, and inspired an art installation at the association’s annual conference at the University of Toronto.

Figure 17.3 shows a graphic illustrating the layers of media technologies that shape our ways of seeing and our modes of being. From the Large Hadron Collider to the Hubble Space Telescope, these layers are generating planetary effects, at once very hot and very cool. The graphic inspired *Rope Over Abyss (Nietzsche’s Telescope),* one of the mixed-media canvases in the overall installation.

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Hot media are concentrated in endo- and ego-media. Hot media promote an *inward gaze*, with the viewing subject and viewed objects in *close proximity* to each other. These *look at* humanity’s socio-cultural activities, the individual and the collective, the self and the other, the profane and the sacred. Examples include cave paintings, drawings, photographs, cinema, television, computers, smart phones and, of course, social media. Hot media deal with higher densities of atoms, matter, events, energy, images, humans and thus are high friction. In proximity, entities can rub or smash against one another. Acceleration, quick reactions, short attention spans, instant feedback loops. *Temperatures are higher, tempers are hotter.* Hence, heat and friction also lie within our global layers of hot media, giant clusters of networks and webs, all jammed with ever more content and contexts.

We live in a hot media visual culture. Everything is in utmost proximity, on our electronic screens and in our galleries and museums — images and artworks collide and crash upon our consciousness. We click from page to page on our screens, wander from room to room in the galleries and museums.

Cool media are exo-media, though they can include eco-media. Cool media provide an *outward gaze*, with objects *further apart* or moving away. Earth is below us, the stars are beyond us and galaxies are moving away. Cool media deal with lower densities, lower friction, with distance, drift, wander, wonder, wow. Temperatures are lower, tempers are cooler. Whatever is hot out there — such as stars, black holes and supernovas — is surrounded by the cool, the void, the entropy towards absolute zero. Big bang to the big chill. Deep space, deep time, deep futures. Current examples are the Hubble Space Telescope, Very Large Telescope, the Atacama Array, Voyager and any other telescopes and space probes. Other examples include aerial imaging technologies such as satellites and drones. Of course, Earthworks are cool, exo-media that direct our gaze into the chilly skies of the Milky Way.

Can hot and cool overlap? Yes. That’s why this is a hot–cool scale and not a typology with fixed categories and clear-cut boundaries. Google Earth gets hotter the closer it zooms in towards Street View but gets cooler the further it zooms out to show Earth as a planet in its totality. Hot and cool art can overlap, but that is a topic beyond the scope of this article.

There is a clear parallel between the expanding size of dark sky areas and the expanding size of telescopes, both terrestrial and those in space. The massive Greater Big Bend Dark Sky Reserve parallels the Giant Magellan Telescope (six round mirrors, each 8.4 metres and surrounding a central mirror also 8.4 metres, totalling 25.4 metres for the light-collecting area) and the Extremely Large Telescope (798 hexagonal mirrors, each 1.4 metres across, totalling 39.3 metre for the light-collecting area). Currently, these are the two largest telescopes, and both are located in the Atacama Desert in the Andes Mountains of Chile. In fact, Chile has become a sort of telescope utopia, with its clear, dark skies and dry air amid the remote mountaintops. It’s likely that the most famous new telescope will be the James Webb Space Telescope (JWST), the successor to the Hubble Space Telescope. Launched in 2021, the JWST was built by NASA, the European Space Agency (ESA) and the Canadian Space Agency (CSA). The JWST has more than 100 times the power of the Hubble Telescope and will be parked 1.5 million kilometres from Earth, at a stationary location known as Lagrange Point 2 (while actually following Earth in its orbit around the sun).

Made possible by powerful computers and the most perfect mirrors ever created, these telescopes produce images that should be considered new media art: Terabytes of data are filtered through digital technologies and converted into images that scientists think best represent the data and thus the empirical reality. Both science and art are present, because the scientists and technicians are making aesthetic judgements about the best image to represent the data ([Kessler 2012](#b-9781474207935-017-0000172)). These cosmic images are represented on screens, like much new media art.

Through the power of cool media, look at what we’ve discovered so far. An epic and wondrous universe—two trillion galaxies, three sextillion stars, black holes galore, billions of planets in the Milky Way, and a cosmic web organized around supervoids and gigantic galaxy clusters that stretch for billions of light years. The energy of this universe is destined to last for trillions upon trillions of years.

All of this means that we need art, the sublime and secular philosophy to get us across Nietzsche’s abyss. In “The Challenge of Every Great Philosophy,” Nietzsche argues: “The whole future of the sciences is staked on an attempt to understand this canvas and these colors, but not the image … for without such a regulative total image they are strings that reach no end anywhere and merely make our lives still more confused and labyrinthine” ([Nietzsche 1956](#b-9781474207935-017-0000184): 125). That is the very challenge embraced by cool media technologies and Earthworks, the chill art form for the sublime, the starting point for the new philosophy to span the abyss.

## Earthworks as Cool Media

Though Earthworks have been created in many countries, the most famous Earthworks are in the American Southwest. Tapping into the ancient traditions of megalithic art around the world, “Earthworks” are massive artworks built into the natural landscapes and environments, which is why they are often described as “land art.” Located in remote areas with awe-inspiring vistas and dark night skies, the goal of Earthworks is to inspire us to look away from ourselves, away from the skyglow-screenglow of our electric civilization, to connect with Earth, nature, wilderness and the universe. Most Earthworks are another form of cool media and new media art.

The mainstream art historians tell us that Earthworks signify a rejection of the gallery system in art centres like New York City, while also reflecting ecological interests in synch with the rise of environmentalism in the 1960s. While true, this still situates Earthworks almost solely as a reaction against the gallery system, as if the Apollo space programme and the emerging vastness of the universe had nothing to do with the existential stance of land art.

Earth floating in the emptiness of deep space, monoliths sitting in the deserts of space cinema and Earthworks sitting in the emptiness of the deserts—all burst into global consciousness in the late 1960s. Earthworks rose to prominence in the Space Age, with the Apollo programme and the media theories of Marshall McLuhan paralleling the Earthworks of Michael Heizer, Robert Smithson and Nancy Holt (among others). Then and there, Earthworks and *Earthrise* both confronted negative space and vast voids.

Earthworks do not gaze upon us, while classic, modern and contemporary artworks mostly do; they look at us, or inside us, and/or at our actions or effects, with objectivity and/or subjectivity. We gaze at each other or inward into ourselves or upon our society and its effects. Abstract expressionism is mostly hot, Earthworks are super cool. Galleries are mostly hot, desert spaces and night skies are cool. The smaller the negative space, the hotter the art. That’s the canvas and gallery wall. The larger the negative space, the cooler the art. That’s the desert spaces and night skies. The closer the proximity, the hotter the art. The farther away, the cooler the art. Jackson Pollock is quantum hot, *Spiral Jetty* is cosmic cool. Andy Warhol is celebrity hot, Michael Heizer is ancient cool. Jenny Holzer is text hot, Nancy Holt is cylinder cool. Cindy Sherman is mirror hot, Teresita Fernández is mirror of nature cool. Dan Flavin is electric hot, Donald Judd is aluminium and concrete cool. James Turrell’s pure light installations are electric hot, while his *Roden Crater* is abyss cool.

Over the years, co-author of this article Barry Vacker has had the good fortune to personally visit several of these Earthworks (except for *Roden Crater*). When the sun sets and temperatures drop, the lower temps naturally help our minds get into the chill gaze, allowing the cool to speak to us.

Cut into the rim of a mesa north of Las Vegas, Michael Heizer’s *Double Negative* (1969) comprises two empty trenches (together about 450 metres long) that directly pose the challenge of the philosophical abyss in the surrounding desert and universe above. Like *Spiral Jetty*, *Double Negative* is experienced by looking into the empty space within each trench and away into the empty space beyond—towards the skies or the desert basin running beside the mesa. Negative space surrounds the sculpture and the viewer, forcing one to situate one’s self on Planet Earth, yet within nature and upon the starry tightrope extending into the universe.

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Set on the edge of the Great Salt Lake in Utah, Robert Smithson’s *Spiral Jetty* (1970) is a 450-metre spiral of dirt and boulders that references the Milky Way above, while salt crystals show emergence and entropy over time. This Earthwork is experienced by looking at it and looking away towards the horizon and sky. *Spiral Jetty* is framed by a vast realm of negative space. The aesthetic canvas is the Great Salt Lake, the daytime sky and the starry sky at night. In Smithson’s film about *Spiral Jetty*, the artist includes an image of Edwin Hubble’s famed 1936 book, *The Realm of the Nebulae*, along with this passage: ‘Gazing intently into the gigantic sun, we at last decipher the riddle of its unfamiliar aspect. It was not a single flaming star, but millions upon millions of them, all clustering thickly together … It was, in fact, a vast spiral nebula of innumerable suns’ ([Smithson 1970](#b-9781474207935-017-0000202)).

Set in the flat emptiness of northern Utah, Nancy Holt’s *Sun Tunnels* (1976) are four giant concrete cylinders aligned with the summer and winter solstices; the cylinders are 2.7 metres in diameter and 5.4 metres in length. The holes on the tops of the cylinders align with various constellations. The *Sun Tunnels* is a cool medium that encourages us to look away from ourselves, while the artwork collectively forces us to situate ourselves in the vastness of the negative space of sky, stars and desert.

Built into the edge of a spectacular mesa in northern New Mexico, Charles Ross’s *Star Axis* (begun in 1973 and only now nearing completion) is a giant steel and stone sculpture designed to be a naked-eye observatory aimed at the North Star. You ascend towards the stainless-steel aperture, where you sit on a stone bench that situates the spine parallel with the equator—as you gaze into the starry skies, with the North Star stationary at the centre as the Earth rotates. Is there a better artwork depicting a rope over an abyss? *Star Axis* will be accurate for thousands of years.

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Located in a dormant volcano east of the Grand Canyon, James Turrell’s *Roden Crater* (begun in 1979 and still in development) contains a series of his “skyspaces” and several naked-eye observatories. According to Turrell: “In this stage set of geologic time, I wanted to make spaces that engage celestial events in light so that the spaces perform a ‘music of the spheres’ in light” (see [<https://rodencrater.com/celestial-events/>](https://rodencrater.com/celestial-events/)). Recently, Kanye West donated several million dollars to help complete the project and obtained permission to film a music video inside *Roden Crater*.

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I (co-author Vacker) have found that these sites are all much more impressive when experienced *in person*. The photos of these Earthworks might look great or interesting, but they are not a substitute for being there. That’s because the immensity of the surrounding desert and skies function as “negative space” and set off the Earthworks, forcing us to see them in a *larger cosmic narrative*. It’s the same concept as *Earthrise*, in which the blackness is the negative space that frames Earth in the universe.

Of course, these Earthworks are not easy to visit. That’s part of what makes them special. Far removed from museums and metropolises, these Earthworks inherently situate us in universal narratives of space, time and existence — in direct contrast to the 24/7 hot media spectacle that situates us in the momentary fragments of tweets, selfies, status updates and the endless antics of the human species. Day or night, these monumental Earthworks are new media art that remove us from the centre of the universe and stimulate the cosmic sublime.

## Cool Media and the Cosmic Sublime

Whether at an Earthwork or observatory, directly experiencing the stars and nearby galaxies from both an aesthetic and scientific perspective is thrilling and inspiring. It’s like what I (co-author Vacker) directly experienced at various Earthworks and at the McDonald Observatory in the desert mountains of far west Texas. Seeing the dark skies filled with the radiant Milky Way has enabled me to experience the cosmic sublime and transcendent moments in which I am connected to a narrative much larger than the human-centred narratives that dominate the 24/7 hot media spectacle.

During my many visits to McDonald Observatory’s “star parties” (where visitors are permitted to look at the stars, planets and galaxies through very powerful telescopes), I have gazed upon the Andromeda and Whirlpool galaxies, neighbours of the Milky Way. Andromeda is over two million light years from the Milky Way, while the Whirlpool Galaxy is at least fifteen million light years away. Imagine seeing the tilted spiral of Andromeda, with photons from one trillion stars traversing the voids of the cosmos at the speed of light for two million years—light leaving that galaxy long before any human walked on Earth! On one particular visit, it occurred to me that, after eons of space travelling, the starlight I was witnessing was passing through the telescope’s lenses and into my own eyes; photons from the Andromeda Galaxy were actually converting into bioelectrical patterns in my brain.

Andromeda’s photons merged with my neurons. In that existential moment, my consciousness was reconnected with the cosmos, and a tiny fragment of the universe was directly aware of itself on a grand scale—connecting the infinite and infinitesimal. Though tiny in relation to the cosmos, I felt the exaltation and affirmation of human existence, the power of human reason to grasp what I was seeing and sensing. It is likely I have never felt more inspired and at peace in the same moment. That’s the power of cool media and the cosmic sublime.

When we gaze up at the Milky Way with our eyes, or visit a naked-eye observatory, or peer through telescopes into deep space and across the universe, the amazement we experience is part of the sublime. An aesthetic concept, the sublime has challenged many of the great philosophers, from Immanuel Kant in the eighteenth century to Jean-François Lyotard in the twentieth.

In the conclusion to the *Critique of Practical Reason*, Kant offered this famed statement: “Two things fill the mind with ever new and increasing admiration and awe, the oftener and the more steadily we reflect on them: the starry skies above and the moral law within” (Kant [1967](#b-9781474207935-017-0000163): 260). For Kant, the starry skies above—“worlds upon worlds and systems of systems”—annihilate our importance as individuals and as a species, while reducing our planet to a “speck in the universe” (ibid.). Lyotard believed the cosmic sublime is “the sole serious question to face humanity today” and “everything else seems insignificant” ([Lyotard 1992](#b-9781474207935-017-0000175): 9). In the immensity of the universe, with all its energy and matter, our sun is due to die out in 4.5 billion years and expand to consume Earth, effecting what Lyotard terms the death of human thought. (This will be certainly true unless we migrate to other habitable planets.) Tapping into the sublime in terms of space and time, Lyotard writes, ‘This arrangement is transitory—lasting a few billion years more or less. Lunar years. Not a long time on a cosmic scale. The sun, our earth and your thought will have been no more than a spasmodic state of energy, an instant of established order, a smile on the surface of matter in a remote corner of the cosmos’ (ibid.: 10).

For Lyotard, these cosmic conditions *annihilate* and render absurd the passions that consume society, with its wars, politics, economics and belief that the “smile on the surface of matter” actually matters to the cosmos. Humans are the product of chance and the laws of the universe and have no intrinsic meaning or purpose beyond what we have conjured in our beliefs and thoughts. So far, the cosmos permits us to exist but does not care if we exist ([Sim 2001](#b-9781474207935-017-0000199)).

Borrowing from Kant, Lyotard and other thinkers, here is what we mean by the cosmic sublime: We encounter the cosmic sublime when there’s a tension between our perceptions and our reason. Our senses are *overwhelmed*, yet our minds can still order the percepts into *knowable*, *pleasurable* or *terrifying* concepts. The vast universe includes immense scales of space and time, dynamic systems of stars and galaxies; sprawling voids and seeming emptinesses; immeasurable realms of cosmic destruction and renewal. Such features stimulate our imaginations in awe-inspiring experiences. We grasp the *affirmation* of human rationality and *annihilation* of our centrality. We feel *exaltation* before the universe in tandem with sensing the *extinction* of our species’ dominant narratives and philosophies. We feel the impulse of human *freedom* in conjunction with our *void in meaning*. We can feel connected to the universe or crushed by its vastness (Hoffman and Whyte [2011](#b-9781474207935-017-0000157); [Kant 1952](#b-9781474207935-017-0000166); [Shaw 2006](#b-9781474207935-017-0000196): 1–11, 73–89).

The sublime moment is filled with emotional and cognitive overload. We instantly realize that we are no physical match for the universe, yet we embrace the intellectual challenge of exploring the cosmos via science and technology. The cosmic sublime affirms our right to exist at the same time that it points to the inevitability of our own extinction. The sublime evokes paradoxical and contradictory emotions in us that coexist, side by side, such as pleasure and pain, attraction and repulsion, and power and fear ([Vacker 2017](#b-9781474207935-017-0000205): 13–15).

The telescopes of NASA and ESA also provide profound experiences of the sublime, as do Earthworks. The sublime is a complex existential and *aesthetic* experience, a moment of *radical wonder*, a universal experience that 1) connects us to each other and 2) connects us to our origins and destiny, to nature and the universe from which we evolved. We ardently propose this experience represents the power of Earthworks as a new media art and the importance of protecting dark skies for observatories and Earthworks.

But will the dark skies and Earthworks survive Elon Musk?

## Starlink’s Night Sky Pollution

Are the starry skies soon to be cluttered with satellites? Will the dark skies be ruined above the world’s Earthworks and observatories? Will hot media overtake cool media?

Beginning with the first satellite in 1957 (Sputnik) and up to 2019, there were approximately 4,000 satellites in orbit around Earth. That number is expected to explode in the coming decade. By 2025, more than 1,000 satellites could be launched every year. With approval from the Federal Communications Commission, Elon Musk’s Starlink plans to launch 12,000 satellites (and likely 30,000 more) in low-Earth orbit by 2027 ([Ryan-Mosley, Winick and Kakaes 2019](#b-9781474207935-017-0000181)). Supposedly, the main goal of Starlink is to provide high-speed bandwidth for 4K video on a global basis, surely a worthy endeavour for those living in remote places or underserved locations and are unable to access the internet. Other firms planning to compete with Starlink include Amazon (3,200 satellites) and OneWeb, a UK-based company planning on launching 650 satellites. *All the above means that we could go from 4,000 satellites in* *2019 to over 40,000 in* *2030, an increase by a factor of ten.*

Of course, Starlink and the others will be conduits for the daily torrent of hot media circulating around our planet, along with much new media art that is online. In so doing, Starlink and others may well destroy the dark skies. Consider [Figure 17.7](#b-9781474207935-017-0000124).

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The first Starlink satellites have already received complaints from scientists and astronomers because the satellites are reflecting light back down to Earth and interfering with dark skies needed at the observatories around the world ([Grush 2020](#b-9781474207935-017-0000151); [Clark 2020](#b-9781474207935-017-0000142)). For example, Northwestern University astronomer Cliff Johnson was surveying the Magellanic Clouds (two dim dwarf galaxies that orbit the Milky Way) with the telescopes at the Cerro Tololo Inter-American Observatory in Chile. Suddenly, long streaks appeared in the images from the telescope. For five minutes, a “train of 19 satellites had crossed into the telescope’s view, scarring the observation with bright parallel marks, and degrading their scientific value” ([Resnick 2020](#b-9781474207935-017-0000193)). Clara E. Martínez-Vázquez, a colleague of Johnson, expressed her frustration on Twitter: “Wow!! I am in shock!! The huge amount of Starlink satellites crossed our skies tonight at @cerrotololo. Our DECam exposure was heavily affected by 19 of them! The train of Starlink satellites lasted for over 5 minutes!! Rather depressing … This is not cool!” ([Resnick 2020](#b-9781474207935-017-0000193)).

By stating Starlink’s sky pollution is “not cool,” Martínez-Vázquez is spot on in more ways than one, for this is a clear example of hot ego-media overtaking the territories of cool exo-media. Starlink has pledged to address the matter, though they are still launching the reflective satellites. Caitlin Casey, an astronomer at the University of Texas at Austin, poetically summarizes the issue:

The fact that one person, or one company, can take control and completely transform humans’ experience of the night sky, and not just humans, but every organism on Earth … that seems profoundly wrong. [The night sky is] the one thing that all humans have had in the past 200,000 years, millions of years, it’s always been there … My whole attachment to science and pursuing this as a career dates back to seeing the night sky as a child and being mesmerized. Astronomy is a unique science: we can’t tinker with things in a lab, experimenting on stars. The entire science is looking up at the sky, and losing that would be tragic.

— ([Resnick 2020](#b-9781474207935-017-0000193))

Starlink’s sky pollution involves more than astronomy, for it threatens all Earthworks at night. Under dark skies, there are somewhere between 4,000 to 6,000 stars visible to the naked eye. Currently, the Starlink satellites are brighter than most stars! Under current plans to reduce the reflection, the satellites will still be as bright as many stars. Imagine 40,000 satellites roaming across the sky every night, like ants crawling across an ant bed stretching from horizon to horizon.

## Conclusion

Lost will be the cool gaze that has existed for the human species since its emergence on Planet Earth. Prior to electric light and Starlink, every human being and every civilization that has ever existed was able to bask in the radiance of the Milky Way. We are literally polluting and erasing our connection to our cosmic origins, for we are made of the stardust we see in the Milky Way. If the dark skies could be returned to human consciousness on a regular basis or become easily accessible in national parks and dark sky reserves, then this might help inspire the development of a planet-wide sense of humanity’s shared destiny in a new and singular cosmic narrative. That’s the unstated philosophy in the Earthworks and Greater Big Bend International Dark Sky Reserve. Cool media—in the form of technology and new media art—and the sublime aesthetic experience are collective starting points for ascending the tightrope over Nietzsche’s ever-so-chilly abyss.

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It’s not chemistry, it’s electric.

— [VNS MATRIX (1991)](#b-9781474207935-018-0000228)

The early media technologies of the twentieth century already provoked questions concerning sex and gender, the politics of specific embodiment, the normative gendering of technology, issues of power, exclusion, affirmation, epistemology and ontology. These questions were posed in various registers (e.g. the aesthetic and the sociological), examined through various theoretical lenses (via posthumanism, new materialism, historical materialism, affirmation or critique) and articulated in different forms: as new media art, as matters of artistic practice, as theory, everyday engagement, as declarations, manifestos, media productions, exploits, installations, performances.

Computational technologies, nascent in the early to mid-twentieth century, now saturating global societies and accelerating in reach and puissance, have provoked new ways to explore these questions. One of them that has garnered much attention has been cyberfeminism, irrupting most violently in 1990s, having tentacular links with earlier media art and feminist formations, and reviving in various guises in the contemporary moment, specifically in an accelerationist form. Cyberfeminism has taken many forms and was always more catholic than it is remembered ([Bassett 2001](#b-9781474207935-018-0000081)) but in its inaugural moment it constituted an aesthetic and theoretical response to the rise of the internet and to the net imaginaries it birthed.

Cyberfeminism was variously taken up as strategy, as tactics, as an ontology, as an exploit, and debate between various tendencies was fierce but the whole was characterized by a hostility to normative, masculinist, uncritical responses to net culture; cyberfeminism eschewed boredom, or the net as more of the same. Against the dreams of a Cartesian division, a virtual sublime, the desire for ultimate mastery of the self by way of the disappearance of the self’s self-limiting body and for ultimate mastery of the world by way of its reduction to an abstract grid and its expansion beyond any limits placed by “nature’s” inconvenient finitude (territory, bodies, scales) cyberfeminism typically insisted on fusion of the flesh with the cybernetic, on sutures, on hybridity and on the persistence of the posthuman body in the virtual machine. It was interested in cybernetics and networks, in exposing the gendered bones of the discourses of computing and network society, and in “bluntly sexualising cyberspace and digital technology”, as cyberfeminist and art theorist Yvonne Volkart put it, invoking Linda Dement’s 1995 CD-ROM artwork *Cyberflesh Girlmonster*, and the latter’s desire “to put some guts into the machine” as evidence ([Volkart 2004](#b-9781474207935-018-0000230)). It was also, in some of its forms, interested in gender and its possible termination. Exploring gender confusion via the possibilities for gender switching and passing in text-based worlds such as MUDs and MOOs, life “online” (viewed sociologically elsewhere) became, for cyberfeminist artists, a mode of performance—where gender trouble could be explored with bodies that might not matter (as much); the whole was heavily influenced by Judith Butler’s work, including her exploration of passing in *Paris Is Burning* ([Bassett 1997;](#b-9781474207935-018-0000075) [Butler 1990](#b-9781474207935-018-0000105)).

Cyberfeminism discerned, in the move from the mechanical to the digital, possibilities to loosen or corrupt the coupling that named technology as gendered “masculine”, as Judy Wacjman put it (1991), and that made it a tool of the Master whose Enlightenment job was to expand and extend the empire of the human. It was this vision of progress that cyberfeminism sought to delete, explode, deface, queer or replace with something better. Further, it did so by seizing the tools of its putative production—cyberfeminism was technologically *avid*. It worked, therefore, with the potential of cybernetics and digital media, producing work in the grain of the cybernetic machine. Verena Kuni’s definition of cyberfeminism as “a political and aesthetic strategy … working consciously with means of replication and simulation rather than referring to traditional strategies of representation” ([1998](#b-9781474207935-018-0000151): 15) begins to suggest how this informed the work it produced. Cyberfeminist-aligned artists and thinkers responded to the technologies reshaping media and culture in the 1990s and early 2000s, contributing to net.art, cyborg art, net politics and digital aesthetics in multiple ways and across multiple sites and genres—one reason excavating cyberfeminism matters is because without it any mapping of the digital art of the 1990s/early 2000s, which is, if not when digital media art began, certainly when it exploded, is lacking. Understanding cyberfeminism also contributes to feminisms’ dealings with their histories (specifically those around gender abolitionism, and race and intersectionality). Finally, cyberfeminism histories can inform contemporary feminist-oriented responses to media art as the latter explore emerging technologies and their shifting technological framings—Platforms, Big Data, AI, Machine Learning, the Metaverse and on.

The article is structured in the following way. First feminist artists and theorists active in forms of media art pre-dating the cybernetic are briefly invoked to explore the history of “Cyberfeminism in the 1960s”. This frames the section following, which constitutes the main body of the piece and which explores the cyberfeminist zenith of the 1990s and early 2000s. Two further brief sections then ask why cyberfeminism was eclipsed and finally bring the account into the present day and into the era of AI and platform capitalism, where cyberfeminism appears in revisionist histories, retrospectives and is also an incitement to the generation of new forms of work that explicitly name cyberfeminism as a problematic parent.

This is necessarily schematic and the reality is more complex: echnological feminisms of many kinds have refused teleological trajectories in their thinking of technological “progress”, and digital media art practice as well as feminist media art theory are characterized by reversions, loops and unequal exchanges and appropriations; cyberfeminism itself has certainly “travelled” at uneven speeds, to invoke Said’s sense of this movement through time (1983: 226). There are also connected spatial dimensions to explore: “1990s cyberfeminism”, as it is conventionally understood, was largely an Australian, European and UK affair—with tentacles reaching into the US, a clear tilt towards Eastern Europe and a shifting population spread out more globally. It was not the only form of digital feminism emerging in the 1990s and the boundaries between what “counted” as cyberfeminism and for whom are also significant, reflecting exclusion, power, assumed universality and a neglect of difference. Recent treatments notably include work on black cyberfeminism, doing so in part with an eye to future developments, but also with restitution in mind. Work by [McMillan Cottom (2016)](#b-9781474207935-018-0000157) and [Richard and Gray (2018)](#b-9781474207935-018-0000211) are representative here. My aim in organizing and writing this entry has been to point to what has become canonical and to attend to *the exclusions operating* *at the time* of cyberfeminism’s zenith.

There are various useful markers that may be used to chart cyberfeminism. One is provided by events at the ICA in London. In 1968 it hosted “Cybernetic Serendipity”, one of the first major exhibitions of computer art. This was followed in 1994 by “Seduced and Abandoned: The Body in the Virtual World”, a response to the internet moment, in which cyberfeminism took a leading role, and finally by the 2017 “Post-Cyberfeminist International”. Digital generations (the Net, the Web, Web 2.0, Platforms, ML and AI) loosely correspond to developments in digital media art—cyberfeminism relating more strongly to the Net moment (see e.g. Joanna Zylinska’s use of these divisions in AI art (2020)). A third set of markers invoked here are internal to 1990s cyberfeminism; of note three Internationals directly curating cyberfeminist activities also indicate that even in its early period cyberfeminism was aware of its own evolution. There are also multiple records of cyberfeminist interventions at media arts forums (Arts Electronica, Documenta), electronic lists (nettime, Rhizome), academic conferences (“Virtual Futures”) and in publications like *Mute*, which described itself as “the arts and technology” newspaper—and as “Proud to Be Flesh”.

Finally there is the question of cyberfeminist art itself; and here there is a strange lack—there are few cyberfeminist works in Rhizome’s net.art collection for instance, and very little cyberfeminist work in major collections. It might be said of cyberfeminism as an art practice that it produced much less than was rumoured, that it was at least as much a theoretical investigation as an art practice, and that what it produced was to some extent hostile to its own preservation being ad hoc, performative, DIY and to some extent anti-art. It was certainly interested in disturbing the art market—as more or less conceptual works by Sollfrank (*Female Extension*) and Lialina (*Art.Teleportacia*) indicate; both mocked the institutions of exhibition and the values of the art world. Drawing these markers together, an opening statement about cyberfeminism might be made: Cyberfeminism can be regarded centrally as a political and aesthetic tendency organized in response to the rise of the internet into the popular consciousness and into (relatively) popular usage in the 1990s and slightly later. This was the period in which cyberfeminism as a theoretical intervention and art practice was most active, and most influential, and when cyberfeminism offered a response to cyberspace and inaugurated forms of thinking about future life in a cybercultural society Accordingly in this article the term is taken as centrally naming this specific and temporally located emergence rather than being understood, as it also sometimes is, as indicating a broader tendency or orientation.

## Cyberfeminism in the 1960s

Cyberfeminism began in the 1990s and as soon as it was born it invented ancestors; variously invited, invoked or—occasionally—self-identifying. In a call for cyberfeminism “with a difference” Rosi Braidotti linked in female media artists including Cindy Sherman, Jenny Holzer, Laurie Anderson, Nel Tenahof and Catherine Richards (Braidotti 1996). A virtue of Braidotti’s list for the purposes of this article is that while (necessarily) incomplete, it underscores the range of work that fed into what became cyberfeminism. Digital media art is enmeshed with film and performance art, video art, photography, and in all these areas contributions towards a genealogy for cyberfeminism might be identified. In many cases this involves drawing together what was largely discrete—for instance a resource for cyberfeminism can be discerned in the work of landmark Second Wave feminist artist Judy Chicago, via the *Dinner Party* (1976), which became the inspiration for a long-standing cyberfeminist intervention via Kathy Huffman and Eva Wohlgemuth’s FACEs project, which featured in the First Cyberfeminist International (1998: 78), and was shown internationally. There are also individual artists who have made their own crossings. Of note is Lynn Hershman Leeson, whose feminist work links avant-garde photographic practice, documentary film, including the 2010 *Women, Art Revolution*, and performance to cyberfeminism, with which she identified, and which she explored via *Ada* (a film starring Tilda Swinton), and in work on “imaginary personalities”, including a long-running private performance as the fictional character Roberta Breitmore beginning in 1973. In between times Hershman Leeson showed at “Cybernetic Serendipity”, to which I now turn.

Computer art, dealing directly with the possibilities of the algorithmic, rather than the televisual or video-based, inaugurated new forms of work and the ICA’s “Cybernetic Serendipity” (1968) is a landmark here. It included “graphics, films, music, texts, devices and robots and sculptures”, as its promotional poster notes. It didn’t include many female artists—Hershman Leeson was an exception. However, it was curated by a woman, Jasia Reichardt, a British art critic, writer and curator of the Themerson archive. In the aftermath of “Cybernetic Serendipity” Reichardt wrote “Machines and Art” for *Leonardo* (1987), exploring the “image of the machine” and the future of art and invoking Picabia’s *Girl Born without a Mother* to argue that new computational machines were “most brilliantly plastic” (1987). In the main, however, “Cybernetic Serendipity” was distinctive not so much for the “plastic” qualities of what was shown; what was foregrounded was rather the automatic or even the diagrammatic. If Futurism was one precursor to thinking the machine, as Reichardt rightly noted in the same essay, the cybernetic system with its grid aesthetic was another. Cyberfeminism of the 1990s responded to preoccupations of both.

## The Zenith of Cyberfeminism

The cyberspace era notoriously began with William Gibson’s *Neuromancer*, with “lines of light ranged in the non-space of the mind, clusters and constellations of data, like city lights receding” (1984: 51). More sober accounts recognize it emerged through complex industrial, social and political processes nowhere near so easy to date, but Gibson’s writing of cyberspace captured the sense of excitement around the net. As Julian Stallabrass put it: “Suddenly, it seemed, following the rise of the browser, there was a dynamic technological, cultural and social scene, subject to dizzying change, and open to social and political manipulation” (2012: 129).

Excitement around the internet was founded in very different readings of its potential—expansion of markets, or escape from the commoditized enclosure, free cyberculture or free beer, temporary autonomous zone or new frontier to be settled. What was shared was the sense of a change in space; cyberspace was widely viewed as a new terrain of activity in which old divisions, binaries, might founder, or be challenged. The Electronic Frontier Foundation’s *Declaration*, proclaiming that cyberspace is “both everywhere and nowhere, but it is not where bodies live” ([Barlow 1996](#b-9781474207935-018-0000073)) said it frontier-spirit, masculinist, colour- and gender-blind “universalism” and all This space at once suggested a transformed experience of the body, and its negation; in this *non-space* space it was argued bodies might also become virtual ([Paasonen 2011;](#b-9781474207935-018-0000177) [Penny 1995](#b-9781474207935-018-0000182)).

Cyberfeminism responded to this tension, indeed if graphed it snaps to the cyberspace grid, both terms rising into prominence in the late 1990s and then falling back sharply before regaining some ground in the later post-9/11, post-net era, when they have nothing like the same definitional power. It has been declared a spontaneous emergence: VNS Matrix, a Sydney-based artists’ collective, claimed to have “invented” the name, while in the UK cyber-theorist Sadie Plant declared she had arrived at it independently. In Europe the Old Boys Network (OBN) first came together as a network at Documenta 1997 via a residency in the Hybrid Workspace but had formally constituted itself as a group slightly earlier. All these groups connected; cyberfeminism as a milieu, an art practice and a theoretical intervention was highly networked—and not only to itself but also to others exploring media art, tactical media, digital revolt and feminist and posthumanist theory. For instance VNS Matrix members featured at “Virtual Futures”, the Warwick University conference on cybernetic culture, and “Seduced and Abandoned” and Plant herself originated one and led another. The Internationals meanwhile included VNS matrix members. Many other artists and theorists attended events at all three nodes.

Indexing cyberfeminism has become a popular pastime in recent years (see e.g. Monoskop’s excellent collections online ([Monoskop n.d.](#b-9781474207935-018-0000163))) so here, rather than attempting a yet more exhaustive list, these three cyberfeminism nodes, each espousing a distinctive “flavour” of feminism, are now considered at closer range. More commentary is then needed, however, since sharp debates criss-crossed cyberfeminism, and tensions around race, difference, ontological and political feminisms emerged at cyberfeminist events (and in this sense are to be viewed as part of its whole) and surfaced on listserv and other debating spaces. Relevant here (and briefly explored further below) are Maria Fernandez’ critiques of cyberfeminisms’ faithless cyborg politics (where what is broken faith *with* is the socialism of Donna Haraway’s 1985 “The Cyborg Manifesto” (1991). Nathalie Magnan named “The Cyborg Manifesto” as “the holy text of cyberfeminism” at the Very International, as Susanna Paasonen notes (2010). Haraway herself was said to be surprised to be named a cyberfeminist, according to contemporary nettime commentary, reported on nettime). Faith Wilding’s work with the US-based art collective subRosa, which points to a more historically materialist art practice and intervention, is part of this debate, and is also further considered below.

## Australian Cyberfeminism: The Direct Line to the Matrix

VNS Matrix were Australian performance artists mostly known for the *Cyberfeminist Manifesto for the twenty-first Century*; opening line—“We are the modern cunt”. Other productions included *ALL NEW GEN*, and *Corpusfantastica MOO*, which explored gender experimentation in text-based virtual life in the online community LambdaMOO via reports delivered via Francesca da Rimini’s netcharacters “GashGirl”/“Doll Yoko”, from her hypertext ghost-fiction *Dollspace* (1997–2001).

VNS Matrix were “merchants of slime”, self-declared “terminators of the Moral Code” and were also Virginia Barratt, Francesca da Rimini, Julianne Pierce and Josephine Starrs. They saw a feminine principle in new technologies and notoriously proclaimed that “the clitoris is the direct line to the matrix”—in some of their promotions the line appears directly above a credit to the Australian version of the Arts Council …

Avowedly influenced by French theory ([Pierce 1998](#b-9781474207935-018-0000188)), as well as entranced by the possibilities of fluid bodily practices in virtual spaces, and of machinic incursions into real flesh via installations, they insisted on the body—on the sexed meat *and* the machine code. They adopted a low-tech visual aesthetic, even while they produced work that made innovative use of the emerging technologies of the network—their work was also striking for how it exploited the new possibilities of circulation; the line from the *Manifesto* becoming the “content” of multiple feminist interventions on the net, it was perhaps an early meme. VNS Matrix placed the loud, the brash and the leaky against the closed green screens of informatic capitalism. A comparison made at the time was with Char Davies’ industrially backed and beautifully smooth VR work *Osmose* (see [Davies 2003](#b-9781474207935-018-0000108)), which enjoyed serial exposure, but which was critiqued (for instance by Simon Worthington in *Mute*) for the distance it failed to take from the smooth industrial surface of emerging computational capitalism and Silicon Valley. *Mute* also noted that VNS Matrix was counterproductive—being notorious for “the quality of their vapourware” ([*Mute* 1996](#b-9781474207935-018-0000165)).

## The Old Boys Network

The Old Boys Network was founded in Berlin in spring 1997 by Susanne Ackers, Julianne Pierce, Valentina Djordjević, Ellen Nonnenmacher and Cornelia Sollfrank. A core group that emerged included Verena Kuni, Helene von Oldenburg, Claudia Reiche and Cornelia Sollfrank, but there were other regular or semi-regulars (Faith Wilding, Marina Gržinić, Rachel Baker, Yvonne Volkart, Alla Mitrofanova, Nat Muller, to name a few). The OBN brought together a broad group of artists, academics, producers and students. It had strong connections to net activism nodes in Western Europe, notably in Holland (including e.g. Geert Lovink and associated tactical media, and critical media art circles), and to Eastern European artists and theorists. The OBN held three Cyberfeminist International(s)—The First (1997), Next (1999) and Very (2001)—engaging artists and theorists with questions of cyberfeminism. The OBN’s best-known collective work is the 1997 “100 Anti-Theses of Cyberfeminism”, a multi-linguistic and eclectic set of statements of what cyberfeminism is and is not—fashionable, a theory or an institution, for instance.

The International publications constitute the most elaborated theoretical, artistic and aesthetic accounts of cyberfeminism—with theory regarded by many there as a form of art practice or “operation” (see below), and there is some consensus that cyberfeminism as a digital media art intervention had its strongest expression through the network. Recurring themes included bodily modification, desire, play and (playful) political resistance. Much of the work was broadly speaking net.art—including conceptual works, and public art of various kinds, and there was also a strong performance strand. A key sensibility was the hack, and its feminist *détournement*, and a shared aesthetic was often DIY. What most strongly characterized the OBN, however, was the mix of theorists and art practitioners it brought together. A founding intention was to be plural and open, and to engage diverse forms of practice and theory *in* cyberfeminism—which was in turn to be described *through* them. Cornelia Sollfrank, writing on nettime, said the OBN set out to be a *platform*:

i, personally, always understood cyberfeminism as an operational mode which is first of all, based on activity, which means you become a cyberfeminist by developing your own cyberfeminist theory/ piece/ work/thought – whatever medium you prefer to work in – and contribute this to the discourse. the discourse, at least the one around obn is not just open enough to allow all possible approaches, but obn’s basic idea is to build platforms which allow exactly this.

— ([Sollfrank 2001](#b-9781474207935-018-0000219))

The OBN’s platform politics—expressed in its negative theses—were intended to produce a space for diverse practice and/or (or sometimes *as*) theory; historical materialist analysis was to clash with more-or-less Deleuzean materialism, various forms of art practice were to be entertained—from the highly conceptual to action-based art research, from the exploit to production of altered bodies.

## Zeros + Ones

The OBN’s goal of open platforms contrasts with Sadie Plant’s cyberfeminism, which admitted no doubts, left little space for alternative positions and which threatened to become an orthodoxy. Plant co-led Warwick’s Cybernetic Culture Research Unit (CCRU) with Nick Land and brought cyberfeminism to the “Virtual Futures” conference; the programme included Plant herself, the biotech and body artist Orlan, artist Linda Dement and many others. Plant is best known for *Zeros + Ones*, often viewed as the *ur* document of cyberfeminism of the 1990s. This is paradoxical since Plant herself commented that what she was espousing was an “irresponsible” feminism’, one that “might not be feminism at all” ([Plant 1996](#b-9781474207935-018-0000194): 182). *Zeros + Ones* asserts that technology, thought to be singular and masculine, has been revealed via the net, with its zeros as well as its ones, as not one—as women, following Irigaray, are “not one” (Plant too was interested in French theory); on which basis a feminist politics might no longer be necessary. Cut loose from patriarchy, woman is now “turned on with the machines”, the internet providing space for woman to assemble herself “with a little help from her (new) friends”, as I put this at the time, in *Mute*’s issue on cyberfeminism ([Bassett 2009](#b-9781474207935-018-0000087)).

*Zeros + Ones* fused the theorization of virtuality in the tradition of Deleuzean potentiality and becoming with the new (differently) virtual space of the internet. Plant’s thinking aligned with (developed) Warwick’s posthuman approach, but her writing style owed much to her earlier work on the Situationists; *Zeros + Ones* is a radical gesture; as much an aesthetics as a politics.

## Critique, Division, Dissension, Difference

*Zeros + Ones* was controversial inside cyberfeminism, but certainly stands as cyberfeminisms’ most powerful and sustained production. As such it became a lightning rod for internal and external critique of cyberfeminism in general, of which it was often assumed to be a synecdoche ([Paasonen 2011](#b-9781474207935-018-0000177)).

The charge against Plant was of espousing an ontological essentialism that negated difference (in the genealogies it discussed) and of exchanging critique for a form of abandoned jouissance. In the art press *Mute* launched critiques of cyberfeminism as offering an essentialized view of women, as Julian Stallabrass notes ([2012](#b-9781474207935-018-0000221)) but cyber-theorists beyond the art world were also uneasy. Both Plant’s ontological essentialism, and the slippage into textual worlds of cyberspace, were critiqued for routing around the problems of real bodies—with critiques emerging both from those defining themselves as cyberfeminists and by feminists in contention with cyberfeminism. Braidotti spoke for many when she warned against abstraction: “the last thing we need at this point in Western history is a renewal of the old myth of transcendence as flight from the body … a little less abstraction would be welcome”. Staying with the body also meant staying with the trouble, as this was later put, or refusing the seduction of the post-political. Braidotti’s demand for a different kind of cyberfeminism entailed the development of an affirmative politics responding to difference: “The most effective strategy remains for women to use technology in order to disengage our collective imagination from the phallus and its accessory values: money, exclusion and domination, nationalism, iconic femininity and systematic violence” ([Braidotti 2003](#b-9781474207935-018-0000099): 225).

Braidotti might be termed a critical friend of cyberfeminism and the distance between her views and those of Plant underscores the diverse theoretical positions cyberfeminism of the 1990s entertained, albeit more or less hospitably. Notable here is subRosa and the work of Faith Wilding, long an influential and active member of the OBN. SubRosa, led by Wilding herself and Hyla Willis, originally defined itself as a: “mutable (cyber)feminist art collective combining art, social activism and politics to explore and critique the intersections of information and bio technologies on women’s bodies, lives and work” ([subRosa n.d.](#b-9781474207935-018-0000226)). It evidences the presence in the heart of cyberfeminism of a more materialist, engaged art practice, influenced by STS thinkers including Sandra Harding, and very different from the ontological orientation of Plant. An entry on cyberfeminism.net defines subRosa as a cyberfeminist organization led by artists Faith Wilding and Hyla Willis, adding that “Since its founding in 1998, subRosa has developed situated, trans-disciplinary, performative, and discursive practices that create open-ended environments where participants engage with objects, texts, digital technologies, and critical learning experiences interacting with each other and the artists” ([subRosa n.d.](#b-9781474207935-018-0000226)). In sum it was tactical media, and Wilding also collaborated with the Critical Art Ensemble, providing a link into the broader “electronic disturbance” milieu ([1998](#b-9781474207935-018-0000239)).

Wilding collaborated with another OBN attendee, Maria Fernandez, including co-editing *Domain Errors!,* alongside Michelle Wright ([2003](#b-9781474207935-018-0000124)). Fernandez’ intervention into debates around cybernetic abstraction, and the valorization of the cyborg as its figure, also stressed material conditions, and specifically foregrounded race and class. Her work constituted an attack on 1990s cyberfeminisms’ whiteness—theoretical and actual. Fernandez argued that multiple flavours of cyberfeminism failed to recognize difference and inequality, rendering their position indistinguishable from mainstream industrial views. Writing on nettime she argued:

Electronic media theorists and commercial entities alike maintain that ‘differences’ of gender, race and class are nonexistent in the Internet due to the disembodied nature of electronic communication … The promise of the cyborg as a sign of emancipation obscures the fact that the union of human and machine that such women exemplify results from sheer necessity. These women work long hours under exploitative conditions at tedious repetitive tasks, which are often physically damaging.

— ([2001](#b-9781474207935-018-0000114))

The argument against a fake universalism, read as a hollowing out of the original promise of the Haraway cyborg, was specifically directed at particular forms of cyberfeminism: Fernandez remarked that the VNS Matrix manifesto implied that “all differences among women were subsumed in the Matrix” and noted that “Plant also alludes to the undoing of white supremacy, repeatedly referring to ‘the cultures of the old white world’ but does not elaborate this idea”. (2003:33) However, she also laid a charge against cyberfeminism in general: “Cyberfeminists championed the union of women and machines discarding Haraway’s socialist-feminist and anti-racist politics” (2003: 32; see also [Fernandez and Malik 2001](#b-9781474207935-018-0000122)).

## The Fall

Cyberfeminism was over a few years into the new millennium. The label itself still surfaced; but in its distinctive, intense, 1990s form, where it took shape as an artistic intervention, a theoretical current and an activist milieu, it faded away. As Susanna Paasonen notes in “Revisiting Cyberfeminism” ([2011](#b-9781474207935-018-0000177): 346), this was partly due to pressures on key participants—the OBN fell out, the Cybernetic Culture Unit at Warwick was terminated. But there were wider issues. The fall of the Twin Towers, resurgent nationalism and Bush’s war on terror produced an environment in which the conjoined irony and playfulness of cyberfeminist interventions didn’t thrive. There was also a contraction in its space of possible operation; as early as 1999, Hakim Bey, who had declared that virtual space might be a temporary autonomous zone (TAZ), proclaimed that the internet was dead as a space capable of hosting revolutionary activity ([Bey 1991](#b-9781474207935-018-0000096)). After the dot-com bubble burst of 2001, the internet lost its visionary gleam, and its real subsumption was marked by the advent of Web 2.0, which enabled expansion through commoditization. In these conditions the early hacked aesthetic of cyberfeminism, which gave its productions a claim to constitute an avant-garde were recuperated and popularized. It was certainly the end of the time in which utopian readings of the computational fabric could be supported, and also terminated any sense living online, or living “in” cyberspace could be taken as “progressive”.

Some of those associated with cyberfeminism as media art and media art activism continued to produce under that name (notably Cornelia Sollfrank) and forms of tactical media art flourished after the cyberfeminist zenith—Rita Raley’s 2009 account gathers some representative examples. Net.art itself flourished beyond cyberfeminism’s eclipse but also faded as bioscience, genomic art and more embedded work arose (Critical Art Ensemble’s progression from electronic disturbance to biotech is representative here). Other forms of cyberfeminism moved away from media art to explore other spheres, including artificial life ([Kember 2002](#b-9781474207935-018-0000148)), direct participation, and activism and justice movements; Radhika Gajjala’s and Yeon Ju Oh’s co-edited collection, *Cyberfeminism 2.0* ([2012](#b-9781474207935-018-0000127)) is of note here. Summarized as setting out to explore “what it means to be a cyberfeminist today”, it rejected the utopianism of the earlier moment to attend to “contested aspects of new digital technologies that simultaneously enable political retreat and feminist resistance”.

## Cyberfeminism and the Future?

The final turn here is back to the future. A useful marker is again found at the ICA. This time the event is the “Post-Cyberfeminist International”, held in 2017, explicitly referring to the earlier OBN events and registering their anniversary. The event was co-produced with Helen Hester, a member of Laboria Cuboniks, a collective that developed (yet another) manifesto. This one, “Xenofeminism: A Politics for Alienation”, gained much traction on social media and circulated widely. The conference and writings associated with it together can be understood as an assessment of cyberfeminism as a historical moment, explicitly for instance in Hester’s “n.hypothesis” ([2017](#b-9781474207935-018-0000139)), which declares pre-millennial cyberfeminist thought in “critical need of an update”.

The Xeno manifesto complicates this somewhat, being striking for the degree to which it “updates” theory but simultaneously *returns* to an older cyberfeminist aesthetic. It is more or less derived from net.art—but now given the gloss of the retro; the colours are brighter and it doesn’t glitch, but this is, in style terms, effectively a homage—or a simulation. Xenofeminism, to let the name for this tendency stand, advocates technophile feminism and restores the centrality of critique. Hester defines the stance taken in terms of techno-materialism, anti-naturalism and gender abolitionism. Clearly it has more to do with Haraway’s advocacy of socialist feminism than to Plant’s ontology. It is certainly not interested in a separatist politics of the virtual sublime. On the other hand, it is not interested in play, nor in the ironic mode of the Cyborg Manifesto’s use of political fiction. As a result in its hands the declarative mode which in earlier forms of cyberfeminism undermined itself becomes, despite its energy, more earnest than utopian. It has none of the jouissance of the original cyberfeminism. Its demands—for a sober form of revolutionary reformism, and for structure over tactic—don’t have much to do with cyberfeminism’s impulses to cleave to the tactical, the ironic, the joyful, the subversive. The Xeno manifesto constitutes a feminist response to, or articulation of, accelerationism, elaborated as a symptom of computational capitalism by Benjamin [Noys (2014)](#b-9781474207935-018-0000166) but operationalized and given left Leninist form as a diagnosis and a politics by Nick Srnicek and Alex Williams. There it is characterized by its demands to recouple left emancipatory politics to accelerating waves of technological development, embracing the potential of the computational to build a strategic politics, one eschewing the horizontality of movements, folk politics and in a sense the tactical exploit—neither media activism nor media art ([2013](#b-9781474207935-018-0000242)). Automation, it might be said, overtook the possibilities of what Dave [Beech (2019)](#b-9781474207935-018-0000093) has defined as art as a form of non-capitalist production, or a technologically engaged art which was closer to what cyberfeminism of the 1990s understood itself to be.

## Conclusion

The aim of this article has been not only to look at what cyberfeminism has done, and at what has been done under its name in the past. It has also been to look at how it has travelled; there is an orthodox history of cyberfeminism emerging. And this article has sought to at once acknowledge its force—but also question it somewhat. Cyberfeminism’s history has clearly been subject to some of the pressures that it sought to confound. It is justifiable to make the case that the way cyberfeminism has been memorialized is sometimes unnecessarily judgemental; not least because the intentions of various cyberfeminist interventions—the kind of political efficacity many of its practitioners sought through the practice of making digital art—have often been misunderstood or contracted to those forms that made most noise at the time.

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Humanity is the species betrayed by art, in both senses of that word: the species at once revealed and undone through the agency of art.

Daniel Cottom

— ([2006](#b-9781474207935-019-0000148): 150)

As long as art remains a human practice, based on human thought, perception and agency, it remains an activity and institution that depends on the idea of either direct or indirect human involvement. However, what has become a growing concern for art and the thinking about art’s past and future is its anthropocentrism. The late twentieth and early twenty-first centuries are characterized by what Richard Grusin has called the “nonhuman turn”. Thinkers like Donna Haraway, N. Katherine Hayles, Karen Barad and many more have changed their focus of attention on post-anthropocentric political and aesthetic practices, in which humans and nonhumans co-exist, co-experience and co-produce in distributed cognitive environments, assemblages and networks of humans, animals, machines, software, environments, etc. Posthumanism, as an emergent theoretical paradigm that embraces both the technological and ecological challenges of its time, attacks both the humanist and anthropocentric preconceptions of art. It comes in two forms: it is an aesthetic practice that continues and radicalizes the critique of humanism; and it privileges work that takes the idea of post-anthropocentrism and nonhuman art seriously, literally.

As N. Katherine Hayles, one of the major theorists of posthumanism (see [Hayles 1999](#b-9781474207935-019-0000250)), explains: “Throughout the long and varied tradition of aesthetics, one premise has always, implicitly or explicitly, remained unquestioned: that aesthetics has at its centre human perception” ([Hayles 2014](#b-9781474207935-019-0000259): 158). What one might call a posthumanist aesthetic is therefore thinking about art “outside” traditional (humanist) human exceptionalism. How to think and display a world in which the human is no longer at the centre of representation even while the effects of human extraction of planetary resources have never been more painfully felt. Posthumanism holds the human (or to be more precise, some humans) responsible, while searching for alternative, more ecological, more just and also more accurate models of cohabitation in a world of finite resources and multi-species entanglement, under technological conditions that are, to say the least, ambivalent, maybe even uncontrollable. Its eco-political stance explains why posthumanism in art often takes the form of (political, sometimes polemic) performances that highlight and problematize questions of embodiment, while its techno-critical aspect (not to be confused with science fictional technophobia or techno-scepticism) often takes place in the creative “lab”. In doing so, it is engaged in challenging humanist norms through transgressive forms of “monstrosity” (see [Gomoll 2011](#b-9781474207935-019-0000202)).

The notion of entangled materialities—natural, cultural, technological—leads to art practices that are increasingly aware and critical of art’s anthropocentric bias and which stress or foreground and address the political and ecological issues that new forms of living-together outside a clear distinction between nature, culture and technology raise. In doing so, the traditional idea of the autonomy of art and the special experience, affects or subjectivities it affords, together with the institutions these are embedded in, and which they support and in turn legitimize, all become problematized in posthumanist art or art engaging with and produced under posthuman conditions.

## Posthumanist Aesthetics and Rematerialization

In many ways, a posthumanist aesthetic or an aesthetic of the posthuman is necessarily speculative in its aim to escape and undo a human perspective (see [Askin et al. 2014](#b-9781474207935-019-0000079)). It asks: “What would it mean … to imagine an aesthetics in which the human is decentred and inanimate objects, incapable of sense perceptions as we understand them, are included in aesthetic experience?” ([Hayles 2014](#b-9781474207935-019-0000259): 159). Hayles here engages with what has come to be known as “object-oriented ontology (OOO)” (associated with philosophers like Graham Harman, Levi Bryant, Ray Brassier, Timothy Morton or Ian Bogost) or “speculative realism” (associated mainly with Quentin Meillassoux), which perform critiques of what they call Kantian “correlationism” (see [Meillassoux 2009](#b-9781474207935-019-0000322)). Kant and Western metaphysics ever since have been arguing that the “thing-as-such”, and by implication the “world-as-such”, are not really experienceable outside (human) subjectivity. Consequently, OOO and speculative realism set out to rediscover and re-evaluate an object world prior to and independent from the (human) subject or perceiver. Meillassoux refers to post-Kantian speculative realism as the recovery of “the great outdoors” ([Meillassoux 2009](#b-9781474207935-019-0000322): 7 and *passim*).

The general aim of this shift, one might argue, is moving towards a new, radicalized form of alienation and a rematerialization of aesthetics. Roberto Simanowski, referring to Ian Bogost’s work in particular, speaks of “the alien aesthetic” ([2014](#b-9781474207935-019-0000366): 359ff.) according to which art pursues the question “what is it like to be a thing?” In “The New Aesthetic Needs to Get Weirder”, Bogost writes that a “*really* new aesthetics” would arise “if we asked how computers and bonobos and toasters and Boeing 787 Dreamliners develop their *own* aesthetics” ([Bogost 2012](#b-9781474207935-019-0000104): n.p.). While the aesthetics of other beings might remain inaccessible to (human) knowledge, it might, however, be open to speculation and to art, Bogost concludes. This has obvious implications not only for art but also for design more generally (see [Forlano 2017](#b-9781474207935-019-0000191)) and the disappearing boundary between the two. This “weird aesthetic” wishing to discover “the secret life of things” forms an inhuman perspective that may be particularly suited to do justice to a complex situation in which, on the one hand, technologies and technological objects are starting to gain “smartness” and autonomy (i.e. may be developing their own aesthetics outside human perception), while, on the other hand, a new understanding of human and nonhuman entanglement at an organic, biological level is forming around urgent ecological questions and challenges. In this sense, what Nicolas Bourriaud names “relational aesthetics” allows for new forms of intersubjective or communal experience based on the coexistence of human and nonhuman actors ([Bourriaud 2002](#b-9781474207935-019-0000106)). It also responds to a situation in which matter in all forms seems to be proliferating—a revolutionary situation that characterizes the predominant form of (posthumanist) practice as “postproductive”, as Bourriaud calls it. This reflects, since the 1990s, “the proliferating global chaos of global culture in the information age, which is characterized by an increase in the supply of works, and the art world’s annexation of forms ignored or disdained until now” ([Bourriaud 2010](#b-9781474207935-019-0000109): 13). For artists this means that they “insert their own work into that of others” which contributes to the “eradication of the traditional distinction between production and consumption, creation and copy, readymade and original work [and that] the material they manipulate is no longer primary” (13). Key to both—the new forms of relationality and the new forms of object formation—is the new informational sphere created by the internet. The constant flow and reprogramming this new arch-medium affords lead to a profound transformation of the status of the work of art in which the “artwork is no longer an end point but a simple moment in an infinite chain of contributions”, and thus itself becomes an agent or develops a life of its own (20).

This view opens up the perspective of what Karen Barad refers to as “agential realism”, or “the ontological inseparability of intra-acting agencies” ([2003](#b-9781474207935-019-0000090): 815). Inspired by this, artists like Patricia Piccinini (see below) have been engaging with new forms of more-than-human networks, materialities and agencies in their works of “post-1990 new media art that draws attention to our encounters with new sciences, technologies, and other forms of matter, often in forceful and unexpected ways” ([Mondloch 2018](#b-9781474207935-019-0000328): 1).

## Posthumanist Art

While posthumanist thinkers like Haraway, Hayles, Rosi Braidotti or Cary Wolfe have been stressing the role of art as a source of inspiration and as a practice of “imagineering” posthuman futures ([Rossini 2003](#b-9781474207935-019-0000352)), posthumanism as a label for a significant current within contemporary art practice is (still) quite rare. One of a few early and notable exceptions is Andy Miah’s *Human Futures: Art in the Age of Uncertainty* (2008). In her contribution to Miah’s volume, Sandra Kemp uses the “Self Portraits” by multimedia artist Daniel Lee, fusing human and primate faces, Orlan’s extreme cosmetic surgery and Patricia Piccinini’s hyperrealist waxworks of human and mutant figures, as well as Eduardo Kac’s transgenic bio-art (see below), to illustrate how the new (posthuman) aesthetic is (re)shaping the human and the human self-image. In doing so, it is attempting to keep pace with “ever-accelerating technological advances, from airbrushing and digital manipulation to cosmetic surgery and whole face transplants” (84). Kemp asks: “As digital faces are becoming as ‘real’ as live ones and transplants, how will our identity be affected and what is the effect of new technologies?” (84). A brief discussion of some examples of how both artists and theorists of posthumanism have been collaborating to address and transform this new situation, “our posthuman condition” as Rosi Braidotti calls it (see [Braidotti 2019](#b-9781474207935-019-0000115): 6–39; and [Braidotti 2013](#b-9781474207935-019-0000112)), will illustrate the above.

The main genres through which posthumanist tendencies in art have been expressing themselves are body or performance art, lab or science art, bio- or transgenic art, animal art and eco- or environmental art.

## Body and Performance Art

The Australian artist Stelarc (born 1946) and the French artist Orlan (born 1947) are usually seen as pioneers of posthumanist body performance. Their careers stretch back fifty years, and the developments their works and practices have undergone throughout this time are a good reflection of the emergence of the aesthetic engagement with and transformation of posthumanist motifs and concepts, as Chris Hables Gray notes: “There has been a clear progression in the work of both Orlan and Stelarc from performance art, to body art, to carnal art, to what can variously be described as cyborg art or post-human art” ([2002](#b-9781474207935-019-0000221): 189). As most body artists Stelarc and Orlan see their bodies as design objects, that is, not as a “natural” or “biological” given, but as subject to changing conditions of embodiment and capable of aesthetic and technological transformation. Both are thus interested in redesigning the body and in challenging traditional (humanist, religious or naturalized) norms and taboos concerning bodies, bodily boundaries and the dualistic separation of the body from the mind. Instead, for them and for posthumanism more generally, bodies are neither natural nor artificial but the living proof of the inseparability of both; they are embodiments of “naturecultures” in Haraway’s and Bruno Latour’s term. Both provocatively articulate the assumption that the body is “obsolete” (in its traditional sense), but they do so in very different ways and by different means, which can be mapped back to a certain extent onto gender differences. Orlan’s best-known works are critical and extreme engagements with plastic surgery and female identity and thus address feminist political issues of sexuality, agency and beauty ideals (see [Goodall 1999](#b-9781474207935-019-0000207)). Stelarc, on the other hand, is embracing technological means of connectivity to problematize the notion of bodily extension through prosthetics, networks and technological enhancement. Both, however, can be said to be practising what one might call “posthumanist performativity” and aesthetic rematerialization. Their experimenting on their bodies calls into question a traditional understanding of what it means to be human. Both scandalize—Orlan mostly at a religious-moral and individual, Stelarc at a technological-ethical and social level—through what one might call the “cyborgization” and hybridizing of their bodies. In doing so, their interventions are “prefigurative” (see [Gray 2002](#b-9781474207935-019-0000221)) in that they indicate possible futures of human-nonhuman embodiment where body modification is not predominantly related to remedial prosthetics but becomes a question of choice, new aesthetics and ontologies. In fact, they might prefigure new forms of life and maybe even a new (human or posthuman) species.

Orlan’s work provides a critique of Western notions of the body shaped by Christian, especially Catholic, tradition (see, e.g., *The Reincarnation of Saint Orlan*, 1990–93, at [<https://i1.wp.com/www.orlan.eu/wp-content/gallery/operation-reussie-1990/Successful_Operation.jpg>](https://i1.wp.com/www.orlan.eu/wp-content/gallery/operation-reussie-1990/Successful_Operation.jpg)) and, as Linda Kauffman writes, stands “between past and future, human and posthuman” in performing a “juxtaposition of posthuman technology and ancient religion” ([1998](#b-9781474207935-019-0000294): 64); while Stelarc’s aim in showing the “obsolescence” of the human body is closer to a *trans*humanist notion of a post-biological overcoming of the body and its seamless fusion with technology in order to “burst from [the body’s] biological, cultural and planetary containment in the post-evolutionary age” ([Carr 1993](#b-9781474207935-019-0000121): 10; see, e.g., Stelarc, *Extra Ear: Ear on Arm*, 2006, at [<http://stelarc.org/?catID=20242>](http://stelarc.org/?catID=20242)).

Even though Stelarc or Orlan may today no longer be at the forefront of the avant-garde they stand as representatives of an “early digital-culture posthumanism” whose ideas have become generalized in new media materialism ([Amiran 2019](#b-9781474207935-019-0000071): 105). They coincide and are in dialogue with the beginning of a wider theoretical engagement with the figure of the posthuman in the academy at a time when, as Arthur and Marilouise Kroker claim, “we are all Stelarcs now” (cited in [Smith 2005](#b-9781474207935-019-0000372): 63–86). As such, while Orlan’s work might be more closely aligned with Haraway’s early organic cyberfeminism, Stelarc’s posthuman embodiment mirrors Katherine Hayles’s argument in *How We Became Posthuman* ([1999](#b-9781474207935-019-0000250)), which begins with the assumption that cybernetics has transformed the human body into “a material-informational entity” by “splic[ing] will, desire, and perception into a distributed cognitive system in which represented bodies are joined with enacted bodies through mutating and flexible machine interfaces” (xiv). This posthuman moment, indicatively and aesthetically performed by artists like Orlan and Stelarc, shows the “essential transformation … from biomorphism to technomorphism” characteristic of our time ([Hayles 2001](#b-9781474207935-019-0000253): 305), in which the human and its world is subject to computing. It is also the time when all art becomes digital art, either in directly exploring digital code as a new material sphere or simply as a (post-media) platform from which to delve into a fundamentally transformed, informational-semiotic, world in which virtual and actual reality become thoroughly entangled in a convergence of new, social and mobile media based on ubiquitous computing, databases and algorithms, networks and artificial intelligence (see e.g. [Berry and Dieter 2015](#b-9781474207935-019-0000098); [Crowther 2019](#b-9781474207935-019-0000157); [Grau 2003](#b-9781474207935-019-0000218); [Gronlund 2017](#b-9781474207935-019-0000227); [Zylinska 2020](#b-9781474207935-019-0000437)).

## Science Art/Lab Art

This digitalization process coincides with the rise of modern technoscience more generally. All posthumanist art is therefore technological in the sense that it is produced under the technoscientific and technocultural conditions of the late twentieth and early twenty-first centuries. However, it is precisely this connection between art and technology that is also foregrounded and problematized in posthumanist aesthetics. Art, in fact, has always been technological in the sense that it is a central cultural technology. In other words, art and technology are etymologically closely linked—the Latin *ars* is in many ways the translation of the Greek *techne*; both originally mean craft or skill (in a practical and rhetorical, as well as a creative sense). When Martin Heidegger claims that the essence of technics or technology is nothing technological but, rather, is “poietic”, in the sense of “transformative” ([[1954](#b-9781474207935-019-0000265)] [1977](#b-9781474207935-019-0000265)), he reminds us that humans and technology are co-constitutional, namely that our relationship with technology is originary, which is also Bernard Stiegler’s stance (see [Stiegler 1998](#b-9781474207935-019-0000378)) and one of the starting points of posthumanist thinking. This means that a merely utilitarian notion of technology, which understands technology as basically a (human) tool or a prosthesis, is underplaying the ontological condition our entanglement with technology creates and which, under modern conditions, has become our main challenge. Technology rather than being a human creation implicates the human and acts as a kind of “framing” (in Heidegger’s terms). Or, in other words, the human and “its” compulsion to design are inseparable (see [Colomina and Wigley 2021](#b-9781474207935-019-0000145)).

This insight is certainly not posthumanism’s discovery. Modern art since the rise of industrialization in general can be said to be an engagement with the machinic and its aesthetic and the anxieties and desires that surround it. Futurism was particularly technoeuphoric in its idolatry of the machine and its ideal of man-machine fusion. What characterizes the specific posthuman(ist) condition of our own time, to which contemporary art practice responds, is, on the one hand, an intensification and acceleration of technological development, and, on the other hand, a reaction to the specialization of scientific knowledge this produces and which is driven by economic development. What is going on in the science labs of the world has become of central political, economic and military importance, while, for the general public, this has become less and less graspable. This raises ethical questions, for example whether the genetic manipulation of life is the right way forward. How to inform the public and convince them to accept future scenarios produced by science as desirable in the absence of transparency and verifiability? This becomes of crucial importance at a time when the survival of not only the human species but life in general, on this planet, is at stake, whether this is because of persisting technological or new ecological threats produced by anthropogenic climate change.

Posthumanist art—whether it openly embraces the label or only shares a stake in the issues this specific technocultural condition produces—is concerned with this public role of science, its institutions, its practices and understands itself as a political-aesthetic and techno-social intervention. Art and science—both reliant on and reproducing technology—form “the twin engines of creativity in any dynamic culture” ([Wilson 2010](#b-9781474207935-019-0000408): 6). In this sense a lot of posthumanist art can be described as “science art” ([Stocker and Schöpf 1999](#b-9781474207935-019-0000384); [Ede 2000](#b-9781474207935-019-0000180); [Gould and Wolff Purcell 2000](#b-9781474207935-019-0000212); [Edwards 2008](#b-9781474207935-019-0000183)), or “lab art” ([Reichle 2005](#b-9781474207935-019-0000346)). It is experimental in the literal and scientific sense and asks whether art can not only provide a critical commentary on scientific practice, but also use its latest technologies to make a genuine contribution to scientific exploration and technological (re)design. To this effect, the science-art-lab scenarios necessarily engage in inter- or even transdisciplinary knowledge cooperation and production, as Sigrid Weigel explains, which include “meetings between bioscientists and performance artists, video artists and ethnologists, champions of land art and climate scientists, urban planners and writers, museum historians and architects, filmmakers and neuroscientists” ([2011](#b-9781474207935-019-0000402): 10). Needless to say that this also requires an engagement with and an intervention within the production and practice of scientific research, or “research-creation” ([Loveless 2019](#b-9781474207935-019-0000311): 4ff.). Since art’s social role, however, is not to sanction or to simply illustrate or explain scientific knowledge, but needs to be seen to be disturbing or disruptive, this alliance between science, art and the public is not without dangers and tensions. So while most contemporary posthumanist art is conceptually driven it also involves a variety of technical, media and research skills that are impossible to master by a single person and which instead call for collaboration and inter- and transdisciplinary approaches (see [Gere 2010](#b-9781474207935-019-0000196); [Loveless 2019](#b-9781474207935-019-0000311)).

Outside an institutional framework, the kind of artistic practice engaging with science but also very critical of science practice is often activist in its campaigns, projects, performances, happenings and installations. A prime example of this approach can be found in the work of the Critical Art Ensemble (CAE; see, e.g., *Radiation Burn*, 2010, at [<http://critical-art.net/radiation-burn-2010/>](http://critical-art.net/radiation-burn-2010/)). A collective of “tactical media” artists or practitioners with expertise in video, computer and web design, CAE stage (often participatory) political protest events mainly engaging with biotechnology and bioscience and their role in what they call “global eugenics” and the “flesh machine” ([Critical Art Ensemble 1998 2001](#b-9781474207935-019-0000151): 174ff.).

## Bio-Art/Transgenic Art

This co-involvement of art, science and research is also very evident in bio-art, transgenic art or *l’art biotech* ([Hauser 2003](#b-9781474207935-019-0000247)). While biological processes and structures have obviously intrigued and inspired artists for a long time it is only really with the advent and spread of gene-editing biotechnology or bioengineering that artists have started creating works, often in collaboration with bioscientists working in wet labs and at medical institutions ([Kuppers 2007](#b-9781474207935-019-0000303)), by using human and animal tissues, micro- and other living organisms. “Life” (*bios*) is here used as “raw material waiting to be engineered” ([Catts 2018](#b-9781474207935-019-0000124): 66). Bio-artistic practice ranges from “critical interventions into contemporary biotech practices to proposals for techno-utopian solutions” ([Berger et al. 2020](#b-9781474207935-019-0000095)). The posthumanist dimension of artists working with and on life—sometimes creating new life forms, or A-Life (artificial life, in analogy with AI, artificial intelligence)—implicitly or explicitly involves a critique of humanist ethics based on the “sanctity” of (human) life, or of breaking religious taboos by “playing God”. As opposed to “pure” science, however, bio-art and art transforming at a molecular ([Weibel and Fruk 2013](#b-9781474207935-019-0000399); [Anker and Nelkin 2004](#b-9781474207935-019-0000076)) or genetic level (transgenic art) is about questioning and showing how (scientific) knowledge is produced and the cultural effects this might have. This includes a radical reopening of the question of what it means to be human, animal and alive (see [Grau 2003](#b-9781474207935-019-0000218): 296–336). It also complicates the status of biotechnology as a practice of producing “artificial” life forms that are thoroughly “technical”. By highlighting the production processes involved and turning them into aesthetic and political performances or curated media events, bio-art enters the controversial and contested territory of genetic manipulation and the contemporary “bioimaginary” ([Steinberg 2015](#b-9781474207935-019-0000375)). Through their hybridizing forms, often creating provocatively “monstrous” chimeras, artists are triggering and targeting strong affective and ethical responses from the public, like disgust, fear, wonder, recognition, rejection or inclusion ([Holmberg and Ideland 2016](#b-9781474207935-019-0000271)). In this sense, bio-art performances usually involve multimedia events in which life, technology and their mediation are foregrounded, so that one might also speak of “biomedia” ([Thacker 2004](#b-9781474207935-019-0000390) and [2005](#b-9781474207935-019-0000393)) with its spectators’ “embodied sense” of “the transformative power of life” ([Mitchell 2010](#b-9781474207935-019-0000325): 11).

In the context of what one might call a growing post-anthropocentric awareness of human and nonhuman biological entanglement at a microbiological level (studies of the “microbiome” show that the notion of biological species is not as clear-cut as it might seem and that symbiosis between organisms is the norm and even constitutes one of the main drivers of evolution) bio-art arises out of and tactically intervenes in (micro)biopolitics ([Da Costa and Philip 2008](#b-9781474207935-019-0000160)) and thus challenges traditional notions of bioethics ([Zylinska 2009](#b-9781474207935-019-0000434)). As Jennifer Johung points out, the notion of “life” operating in contemporary biotechnology and bioscience as “living matter that can be reworked” goes far beyond earlier ideas of “organic life”. It is this difference also that constitutes “an opening where art and architecture may intervene—to visualize, situate, perform, publicize, and contest the ways we now manipulate and recontextualize the particulate mattering of biological life” ([Johung 2019](#b-9781474207935-019-0000276): 2). The main political aim of bio-art is to illustrate not only our posthuman but also our “post-natural” condition, in the sense that contemporary biotechnology, biopolitics and bio-art are breaking down the boundaries between (biological) nature, science and art, as well as between humans and animals, or animals and plants, and thus intensify the attack on the (humanist) notion of an “autonomous” (human) subject. Instead they show (human) agency to be distributed or dispersed, entangled within a multi-species context. As such bio-art is located within but also negotiates the more general context of modern biopolitics and biopower which, following thinkers like Michel Foucault, Giorgio Agamben, Nikolas [Rose (2007)](#b-9781474207935-019-0000349) and Roberto Esposito, constitutes a mode of the political “whose distinctive characteristic is that *life itself* in its barest form becomes the direct object of political power” ([Wolfe 2017](#b-9781474207935-019-0000423): 217).

Some of the most important proponents of bio-art are Oron Catts, Ionat Zurr and Eduardo Kac. Catts, an artist, researcher and curator, in collaboration with Ionat Zurr, pioneered the ongoing Tissue Culture and Art Project (TC&A), established in 1996—one of the most prominent projects in biological art project. The TC&A is run through an art-science lab called SymbioticA (see [<www.symbiotica.uwa.edu.au>](www.symbiotica.uwa.edu.au)), directed by Catts, at the School of Anatomy, Physiology and Human Biology, of the University of Western Australia, and highlights the “vulnerability” of biotechnological creations, especially in the form of “semi-living” sculptures, for example, in *Victimless Leather: A Prototype of a Stitch-less Jacket Grown in a “Technoscientific Body”* (2008, at [<https://tcaproject.net/portfolio/victimless-leather/>](https://tcaproject.net/portfolio/victimless-leather/); see also [Senior 2008](#b-9781474207935-019-0000360): 76).

Eduardo Kac’s work focuses on “telepresence and bio art” and combines “telerobotics and living organisms” ([Kac 2011](#b-9781474207935-019-0000288); see also [<www.ekac.org>](www.ekac.org)). Through a combination of robotics, biology and networking it explores the fluidity of subject positions in the post-digital world. Both Catts and Kac are well-integrated into the academic scene and engage with posthumanist theory and its discussion of bio-art. Like all of the artists presented in this article they regularly not only feature but intervene in these theoretical and philosophical discussions, commenting on their own and others’ works and their political or ethical implications (see [Kac 2005](#b-9781474207935-019-0000282), [2006](#b-9781474207935-019-0000285))—a rather typical cooperative approach between posthumanist art practice and posthumanist theory. Kac is probably best known for his controversial “GFP Bunny” project (2000, at [<www.medienkunstnetz.de/works/gfp-bunny/>](www.medienkunstnetz.de/works/gfp-bunny/))—a transgenic lab-art-cum-media-performance work commenting on the creation of life and evolution. The specific point of convergence between Kac’s transgenic art and posthumanist thinking lies in dealing with the implications of new microbiological insights that “we are all transgenic creatures” in a sense, since humans “have absorbed genetic material that comes from nonhumans, in our genome” ([Chalmers and Kac 2013](#b-9781474207935-019-0000136): 78). This realization obviously challenges anthropocentrism, humanism and speciesism and instead produces “vivid new ecologies” that don’t necessarily function according to traditional humanist or human visuality, as Cary Wolfe argues, and thus “subvert the centrality of the human and anthropocentric modes of knowing and experiencing the world” ([2009](#b-9781474207935-019-0000411): 145).

## Animal Art

Bio-art often involves animals—both human and nonhuman—and their unstable boundaries and hybridizations, chimeras that are culturally marked as “monstrous”. However, as Jeffrey Jerome Cohen puts it: “the monster polices the borders of the possible” ([1996](#b-9781474207935-019-0000142): 12), an ongoing process of cultural negotiation that Elaine Graham refers to as “ontological hygiene” ([Graham 2002](#b-9781474207935-019-0000215): 33–7).

Animal art usually evokes these taboos, plays with and transgresses them. In bio-techno-media-political times there is no clear demarcation between animal art, bio-art and digital media art. Posthumanism in fact begins by challenging the boundaries between both “our” traditional significant others: machines and animals. Instead it “de-anthropocentres” the human by foregrounding entanglements, assemblages and hybridizations between humans, animals and machines, insisting that contemporary technologies are merely the latest phase in a long history of human-animal-technology co-evolution. Animal art, as one visual or symbolic expression of posthumanism, can of course use biotechnology “literally” (as in the case of Kac, for example), or figuratively. Examples of such a figurative use are Patricia Piccinini’s artworks, especially her sculptures of “imagineered” (see above) transgenic animals or chimeras. As opposed to Kac’s works or the TC&A, Piccinini’s sculptures do not directly involve “biomatter”. They are not produced in a wet science lab although they do of course make extensive use of digital media technology in their design and manufacture.

Piccinini’s best-known and most discussed work is probably a sculpture called *The Young Family* (2002, at [<www.patriciapiccinini.net/writing/51>](www.patriciapiccinini.net/writing/51)), made of a combination of silicone, acrylic, plywood, human hair, leather and timber. Kate Mondloch describes a typical first “encounter” with Piccinini’s fantastic, but nevertheless hyperrealistic, “monstrous” figures as a “face-to-face with otherworldly biotech-generated creatures” ([Mondloch 2018](#b-9781474207935-019-0000328): 3). These “charmingly grotesque” beings are engaged in everyday activities, in this case, “a nursing family of mutant porcine-bovine-hominoid crossbreeds” (ibid.: 3). When encountered in their exposedness and vulnerability, the hyperrealism does not fail to provoke sympathy alongside disgust, as Piccinini’s installation “allows you to experience yourself shamelessly anthropomorphizing these nonhuman entities”, which in turn “might challenge your notion of what it means to be human in the first place” (ibid.: 3; for an extensive reading see [Mondloch 2018](#b-9781474207935-019-0000328): 65–85).

Provoking further reflection and discussion by evoking our ambivalent emotions and exploring our ability to empathize (an “ability” often wrongly believed to be unique to humans), *The Young Family* is part of a number of installations that display “humanimal encounters” designed to facilitate a possibility for ethical engagement with the nonhuman animal “other” ([Orning 2017](#b-9781474207935-019-0000334): 80ff.). In a time “when flesh is becoming plastic”, Piccinini also asks “what we will do with flesh when we can control it”, and states that “there is a nice conceptual irony in [her] use of silicone—basically a kind of plastic—to create flesh in works that talk about the plasticity of flesh” ([Piccinini 2005](#b-9781474207935-019-0000340): 104). It is a figuration of re-engaging with our animality, or our “becoming animal”, precisely at the time when some humans may be all too keen to finally “overcome” (or rather repress) our (biological) animality and instead fantasize about a fusion with some techno-utopian form of “artificial intelligence” (cf. transhumanism). Animal art is “acknowledging that our place in the world of life is less supreme than we would like to think” ([Piccinini 2005](#b-9781474207935-019-0000340): 105). Piccinini’s “critters” also have a strong element of ecological care built into them. They perform a kind of “anti-Frankensteinian” ethics, rectifying the scientists’ lack of care for their monstrous progeny. Donna Haraway therefore sees in Piccinini’s work an ally in what she and ecological or critical posthumanism more generally see as an opportunity “when species meet” ([Haraway 2008](#b-9781474207935-019-0000239)), namely a “move toward multi-species reconciliation” ([Haraway 2011](#b-9781474207935-019-0000242): 7).

The ethical drive in contemporary posthumanist animal art, as Cary Wolfe puts it, is thus to find solutions that do not speak *for* nonhuman animals, but speak *to* our relations with them and how to take those relations seriously, which “unavoidably raises the question of who ‘we’ are” ([Wolfe 2009](#b-9781474207935-019-0000411): 130; cf. also [Grosz 2011](#b-9781474207935-019-0000230); and [Sutton 2017](#b-9781474207935-019-0000387)). What characterizes contemporary and posthumanist animal art is that animals are not simply “objects” of art and of (human) creative desire; they are treated as “creatures who actively share the more-than-human world with humans, rather than as mere symbols or metaphors for aspects of the so-called human condition” ([Baker 2013](#b-9781474207935-019-0000082): 4; see also [Broglio 2011](#b-9781474207935-019-0000118)). In fact, one way of reading the phrase “animal art” is to take it even more literally than bio-art tends to do, namely by attributing *both* subjectivity *and* agency to animals and to treat animal aesthetics as a practice that is actually performed by (nonhuman) animals—a similar case can of course be made for plants, machines, “objects” or “environments” (see below). The ethologist Dominique Lestel, for example, speaks of “non-human artistic practices” like birdsong, ape-paintings and many other animal “cultural practices” and the (evolutionary) basis they might actually form for (human) artistic practices ([Lestel 2011](#b-9781474207935-019-0000306))—an argument that is made even more forcefully by the posthumanist philosopher Roberto Marchesini, who speaks of the “zoomimetic” origin of art (see e.g. [Marchesini 2016](#b-9781474207935-019-0000314)). By zoomimesis Marchesini designates the fact that human imitation of animals has deeply influenced human behaviour and culture and continues to do so to illustrate “our” strong co-dependence. A case in point in this context, also commented on by Marchesini and Karin Andersen in their co-authored volume *Animal Appeal* ([2003](#b-9781474207935-019-0000319)), is Daniel Lee’s work, especially his series of “Self-Portaits” showing him as a human-primate morph (see *Self Portrait*, 1997, at [<www.daniellee.com/projects/self-portrait>](www.daniellee.com/projects/self-portrait)), or as a “manimal” (the title of an earlier series of images by Lee, in 1993). Lee’s digitally transformed portraits are a literal interpretation of contemporary posthumanist art’s “becoming animal” ([Thompson 2005](#b-9781474207935-019-0000396)).

## Environmental Art, Anthropocene Art, Art and Climate Change

Becoming animal, or in fact re-becoming animal, in the sense of recognizing and responding to our bio-ecological co-implication with nonhuman animals and their environments, is closely connected with a general ecological turn, not only in posthumanist thinking. However, critical posthumanism’s contribution to the debate about climate change and the “Anthropocene” lies mainly in reminding techno-enthusiasts of humans’ biologically entangled embodiment and humans’ responsibilities towards nonhuman others.

If posthumanism went through a “cybernetic” wave in the 1990s and a “digital” one in the 2000s, it could be argued that from 2010 the main conceptual shift is towards engaging with anthropogenic climate change and the “Anthropocene” as a new geological period characterized by the fact that humans (at least those human societies that have been driving industrialization, oil extraction, colonialism and globalization) have become the single most significant geological agent in changes to the planetary atmosphere, the biosphere, the reduction of biodiversity and the ongoing processes of terraforming and increasing toxification. Rosi Braidotti characterizes our “posthuman condition” as being “positioned between the Fourth Industrial Revolution and the Sixth Extinction” ([2019](#b-9781474207935-019-0000115): 2). The Anthropocene—even though its name might be controversial since it contains “Anthropos”, the universal humanist concept of “man” that post-anthropocentric posthumanism has set out to “decentre”—both has a mobilizing ecological force and produces new aesthetic perspectives. It “marks a period of defamiliarization and derangement of sense perception” ([Davis 2018](#b-9781474207935-019-0000163): 63), or *aisthesis* (the Greek word for “sense perception” and the etymological origin of the “aesthetic”). Climate change, according to Heather Davis, entails a “complete rearrangement of our sensory and perceptive experience of being in the world, where the threat itself becomes hard to identify based on the sensory limitations of our bodies” (64). The scale of something like climate change, which in its vastness and complexity goes beyond human perception in both space and time, and surpasses notions of nature, culture and technology, human and nonhuman, has led Timothy Morton to speak of “hyperobjects” as “things that are massively distributed in time and space relative to humans” ([Morton 2013](#b-9781474207935-019-0000331): 1).

Art in the Anthropocene (see [Davis and Turpin 2015](#b-9781474207935-019-0000169)) thus deals with the scalar challenges to the representation of climate, ecology, cosmology and geology (both deep space and deep time, so to speak) and becomes a “polyarchic site of experimentation for living in a damaged world, offering a range of discursive, visual and sensual strategies that are not confined by the regimes of scientific objectivity, political moralism or psychological depression” ([Davis 2018](#b-9781474207935-019-0000163): 64). Through its modelling and “imagineering” ability art may thus provide a space for “dealing with the affective and emotional trauma of climate change”; it can “hold together contradictions” and provide “modes of expression for the collective suffering through and venues to express the emotional toll of living in a diminished world” ([Davis 2018](#b-9781474207935-019-0000163): 65). It is testimony to what one might call the new “geological imaginary” and the contemporary “geological reformation of the human [and nonhuman] species” ([Davis and Turpin 2015](#b-9781474207935-019-0000169): 3), or, indeed, “the geologic now” ([Ellsworth and Kruse 2013](#b-9781474207935-019-0000188)). It also shows that the aesthetic has truly become a “more-than-human” affair (see [Dixon, Hawkins and Straughan 2012](#b-9781474207935-019-0000175); and [Yusoff 2010](#b-9781474207935-019-0000429)). In doing so, and by taking on not only a *bio*logical but also a *geo*logical perspective, it offers “an inspiring means for understanding and communicating the complexity of the biological and mineral entanglements linking species through metabolic pathways and networks” ([Bakke 2017](#b-9781474207935-019-0000085): 41).

In fact, one might argue that what “Anthropocene art” shares with posthumanism is the question of how to deal with the “end of the world” in a post-, or rather, non-apocalyptic way and how to imagine new forms of cohabitation under these circumstances. It is therefore no surprise that many of the installations, projects, events that engage with posthumanism, post-anthropocentrism and the Anthropocene contain features of “earth or land art”—“artistic gestures that are transforming sculpture from the production of distinct three-dimensional objects on pedestals to something less clearly definable, something that hovers ambivalently between architecture and not-architecture, landscape and not-landscape, and that properly belongs to neither” (Krauss, cited in [Loveless 2019](#b-9781474207935-019-0000311): 1). Some of the most compelling artists today “are forging new representational and performative practices to reveal the social significance of hidden, or normalized, features inscribed in the land” ([Scott and Swenson 2015](#b-9781474207935-019-0000354): 1). Following groundbreaking land art projects like Robert Smithson’s *Non-Site* (1968) and *Spiral Jetty* (1970, at [<https://holtsmithsonfoundation.org/spiral-jetty>](https://holtsmithsonfoundation.org/spiral-jetty)), more recent works, by Olafur Eliasson, for example, tackle the even more urgent contemporary ecological issues in their installations using architectural, geological-geographic and climatic elements. Eliasson’s *Ice Pavillion* in Reykjavik (1998), *The Glacierhouse Effect Versus the Greenhouse Effect* (2005) or *The Weather Project* (2003) are cases in point (see [Cavazzini 2010](#b-9781474207935-019-0000130): 238–41; [Blanc and Ramos 2010](#b-9781474207935-019-0000101): 148–55). In one of his most recent works, *Dark Ecology* (2016, at [<https://olafureliasson.net/archive/artwork/WEK110441/dark-ecology>](https://olafureliasson.net/archive/artwork/WEK110441/dark-ecology)), Eliasson combines watercolour techniques with using “chunks of ancient glacial ice that were fished from the sea off the coast of Greenland” ([Eliasson 2016](#b-9781474207935-019-0000186)).

## Conclusion

I want to conclude with one artist who openly engages with posthumanist theory and also embraces the label for her art practice, Eija-Liisa Ahtila. Her multimedia installations often relate to “human drama” but are also fundamentally about new forms of empathy and perception with a strong ecological element in their post-anthropocentric message. Often they also involve an important aspect of animal art in that they challenge human perception through plant and nonhuman animal perspectives. Her *Studies on the Ecology of Drama* (2014, at [<https://crystaleye.fi/eija-liisa_ahtila/installations/studies-on-the-ecology-of-drama-1>](https://crystaleye.fi/eija-liisa_ahtila/installations/studies-on-the-ecology-of-drama-1); see [Chaffee 2015](#b-9781474207935-019-0000133)) uses sculpture and video installation to create narrative positions and ways of filmic focalization that challenge the centrality of the human viewer by foregrounding the perspective of a swift. Technologies are here shown to enable humans to overcome their physiological “limitations” to see the world differently and to develop new, hopefully more ecologically sustainable sensibilities towards the planet and nonhuman animals (see [Dinkla 2019](#b-9781474207935-019-0000172); [Cavazzini 2010](#b-9781474207935-019-0000130): 44–5; and [K21 2008](#b-9781474207935-019-0000279)).

Cary Wolfe sees Ahtila’s work as paradigmatic of an artistic engagement with biopolitics in which concerns like “domestic space, immigration and colonialism, sexuality, gender, and animality … relations between the realms of the human, the animal, and the divine (or transcendent)” all combine to show that there is no human “immunity” to environmental entanglement ([Wolfe 2015](#b-9781474207935-019-0000417): 82). In her interview with Wolfe, Ahtila admits that reading Jakob von Üexküll on “Umwelt”, Giorgio Agamben on “bare life” and J. M. Coetzee on “the animal” as well as Wolfe’s own texts about posthumanism and biopolitics has been transformational, especially for her more recent work ([Ahtila 2015](#b-9781474207935-019-0000065): 119). Ahtila, in many ways, could thus be seen as the epitome of a contemporary (critical) posthumanist artist. She combines a critique of technology, human-centred vision and narrative, humanist anthropocentrism, exceptionalism and speciesism with an aesthetic informed by new feminist materialism, ecocriticism, animal studies and object-centred or nonhuman ontologies.

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Much of digital media art is absurd. Or, to put it another way, there is something about digitality itself that has a haunting sense of absurdity. As a starting point, we can say that over the last few centuries Western culture repeatedly found technology, from mechanisms to automation, somewhat absurd. It is also the case that modernity itself, in the way it operates through the reflexive distance of rationality and its ruptures, has been perceived as headless, or rather soulless, and thus inclined towards the absurd. Consequently, art of the modern day and one that has seriously engaged technological media has inescapably had an element of absurdity about it or in any case had to deal with absurdism even if to try to overcome it completely. In what follows, we focus on digital media absurdity and draw upon artworks to saturate the notion of absurdism with a density that does justice to digital media art. Throughout this article, we will be giving pointers to a possible definition of digital media art absurdism, or alternatively the absurdity of digital art.

## Body and Identity

Choosing to work with the new material of digital media, new media art pioneers found themselves in a dimension that was as exciting as it was frustrating: they had to reckon with dial-up internet; low bandwidth, screen and image resolution; glitching software; the narrow expressive range of graphics; and a handful of forms inherited from the industrial paper office, such as folders, bins and buttons. In the 1990s the abundance of the human sensorium had to be reduced and partially shut off to engage with the online. What new media art lacked in digitality, in terms of variety of material, shape, colour, form, spatial depth, biology, speed, sound, scent, it compensated for with global connectivity and communication, collaboration, automation, computer logic and calculative power, information complexity and many other new and exciting capacities. In the 2020s, the human sensorium is thoroughly digitized, datafied and computed for prediction. Nevertheless, *there is a sense of incongruity at the base of digitality*. We feel it as a divorce between the intense attention of the eye and the ache in the bottom from prolonged sitting, frustration at interruption to streaming and exasperation at an online booking system. It is there in the unsustainable addiction to social media, in the absurdity of the “Instagram face”, in the scroll of doom and in putting one’s best self, who couldn’t be further away from who one “really is”, on one’s Facebook page. The incongruity rests in the rupture or enforcement of sensation, the cunning of representation, the swerving intensification of human-digital processing that we learn to rely on, block out or put up with.

The merger and translation of sensory experience onto digital media took absurd comic forms in some of the early net art projects that focused on the fault lines of the body. Sensation is not a blissful hideout from the unbearableness of rationality; it can be overwhelming and disorienting. Alexei Shulgin’s *This Morning* (1997) is a simple web page with black words on white background: “Well I woke up this morning and realised that”, followed by pop-up windows with different messages, including, “I want to eat”, “I want to drink”, “I want to piss”, “I want to work”, “I want to f\*\*k”, “I want to smoke”, etc, with sliding “all at once” scattered around the index page. “Desires are tearing me apart”. At some level, this project is an existentialist declaration of absurdity. Repetitive and exceptionally plain, its performance is delineated by the mechanistic dynamics limited to the HTML of 1997, and even today it is overwhelming. The viewer has to “enable pop-up windows” in their browser; they will then have to force their browser to quit, as the popping-up windows don’t go away.

On the most superficial level, digitality involves dealing with ruptures in the human sensorium so that we find delight in gestural, necessarily formalist and in a certain way minimalist artworks that work with this medium. Shulgin’s *FUFME* (2000) is another absurd attempt to quelch bodily needs with the offering of networked communication. Pronouncedly unworkable with visibly impossible (at least for female users) designs for having sex online, the project is all but mockery of the human sexual drive. It’s rude, and not only in its visual form. Neither intimacy nor exhibitionist eroticism conjugate with the sharpness of computer graphics that depict the use of this imaginary product as a kind of medical, surgery-room procedure. Formalism, noted Mikhail Bakhtin in the 1920s, exhibits a nihilistic tendency ([Bakhtin [1928] 1991](#b-9781474207935-020-0000061)). *FUFME* is nihilistic, and not necessarily in its treatment of the human body. It is a mockery of technological revolution and capitalism, eager to valorize any new development. Multiple arrangements for having sex via computers online, which aim to generate commercial revenue for platforms that host, stream and generate sexual images or interactions, were developed in the years following, making *FUFME* into a cautionary tale. If early art projects engaged complexly constructed emotion (see, for example, Paul Sermon, *Telematic Embrace,* 1992), today designing for addiction (for instance, to social media) means addressing the creation of technological forms directly to hormonal functions (such as dopamine release).

*ZYX*, an iPhone app launched in 2012 during the hype of app productions by the Dutch/Belgian duo JODI, is perhaps less nihilistic, but similarly absurd in how it addresses the human body. Looking at the mobile phone as an extension of bodily functions, the app instructs the user to perform movements, ranging from spinning and swinging the phone to blowing into the microphone, searching for North and standing still. The movements are captured and played back, intercepted by a flashing mix of images in between. The project is often described as staging a participatory performance, but the absurdity of such a soliloquy of actions is clearly delineated by the choice of movements that are outside of the usual repertoire of human–machine interaction. Yet, these movements are easy to do. The absurd is illogical even when it is visibly logical, like instructions to perform banal physical movements in space. It addresses the physical relation bodies have with small machines, which in some cases may lead to near-sightedness, deregulation of muscles and a need for physiotherapy.

Considering the three examples above makes it clear that the absurdism of digitality is not founded on disembodiment. In other words, *the incongruity of the digital absurd is not a mismatch between the body and the mind*. To extend the argument further, the body, but also gender and ethnicity, are not reducible to biological realities and are constructed in multiple dimensions of human experience, whether online or offline. There is a wealth of scholarship and art dealing with, for instance, racialization online, which began in the 1990s and continues today in relation to algorithmic bias ([Nakamura 2007](#b-9781474207935-020-0000103)). Neither does such incongruity rest within the “superiority of the analogue”, whether it is a sensation, experience or quality of time and space. Brian Massumi aligned the analogue, as a physical property of waves of sound, light, temperature or voltage, to sensation, incompleteness and, ultimately, a potential for “thinking and imaging virtuality”, while linking the digital and discrete to quantification, predictive calculation of possible options and, thus, possibilistic control ([Massumi 2002](#b-9781474207935-020-0000097): 137). At the end of his essay, Massumi proposes that instead of obsolescence, there is a continuing cooperation and intertwinement of the analogue and the digital.

Indeed, there is a constant and smooth translation of analogue into digital into analogue, for instance in the operation of loudspeakers or headphones, and we don’t find them absurd. Quantified body devices can be helpful to people. The digital engages our bodies and emotions directly, before we know it. Still, throughout decades and including today, technical imagination of the body, emotion and sensation keeps bordering on keen absurdity, whether it is *FUFME*, Google Glass or metaverse. It offers a human user a reconfiguration that includes a certain openness to violence, new, subtle and previously unknown kinds of upset, assault and grievance. Violence is absurd by default.

A great number of projects work with this theme. Gordan Savičić in his *Constraint City. The Pain of Everyday Life* (2008) created a corset with high-torque servomotors and a Wi-Fi enabled game console to be worn as a fetish object. As the user walks around the city, the sensors pick up wireless signals of nearby encrypted networks. The higher the wireless signal strength, the tighter the corset becomes. *Constraint City* maps a city in terms of the strength and volume of wireless networks while mapping the body with bruises. Various kinds of bruising are common with digital media, whether it is a result of being individually targeted by trolls or a systemic outcome, for instance a feature of the job of the social media content moderator (e.g. Eva & Franco Mattes, *Dark Content*, 2015). Eva & Franco Mattes’ *BEFNOED* (*By Everyone, For No One, Every Day*, 2013) was created by asking anonymous workers across the world to perform simple actions based on text instructions in front of a webcam. The work recalls conceptual art practices in which instructions scribbled on small notes were enough to be art, and responds, at the same time, to the labour critical works that emerged when Mechanical Turks became more commonly known and used. The artists distributed the resulting videos via Tumblr for the occasional viewer to encounter, yet the art public in the galleries was forced into a series of physically awkward and bizarre positions, making them take on the context of art production. Here the body as workforce is reassociated with the social and political labour conditions of the new reality of human–machine relations.

A striking example of the violence of the construct of race is the eBay auction of *Keith Obadike’s Blackness* in August 2001. The auction was part of the “Black.Net.Art” actions by artist duo Mendi + Keith Obadike and it began on 8 August to be online for ten days. After four days and twelve bids, reaching $152.50, eBay closed the auction, quoting the “inappropriateness” of the item. Following the default descriptions of eBay, the bid started with enumerating the pros of buying Blackness, such as “This Blackness may be used for securing the right to use the terms ‘sista’, ‘brotha’, or ‘nigga’ in reference to black people. (Be sure to have certificate of authenticity on hand when using option)”, and juxtaposing it with a list of “warnings” of the downsides of owning a Black identity, for instance, “The Seller does not recommend that this Blackness be used during legal proceedings of any sort. The Seller does not recommend that this Blackness be used while seeking employment”. Amplifying the idea of generic Blackness while simultaneously emphasizing its absurdity, the project undermined the popular idea of the emancipatory potential of identity play of the early web. Instead, Keith Obadike emphasized that web technologies, and their myths, were based on “the language of Western colonialism, from Netscape Navigator to Internet Explorer, eBay.com and Amazon.com” ([Dean 2019](#b-9781474207935-020-0000068): 171), linking libertarian enthusiasm to the history of colonialism and slavery. By layering bodies, minds and technologies in an acerbic response to the idea of web-based emancipation, Mendi + Keith Obadike show how companies as well as platforms and their publics continue racializing people.

The discussion of gender and technology has its own entry in this volume. Here, we would like to briefly mention *GashGirl* by Francesca da Rimini et al. (1997). Francesca da Rimini’s alter ego Doll Yoko or GashGirl emerged already in the mid-1980s, but her ghostly character developed into an absurd virtual identity in the mid-1990s through various email relationships and narrative exchanges in online communities. Partly collected together in the novel *FleshMeat* (1998), an infinite pond of dead girls in dollspace appears to critique the misrepresentation and misrecognition of women in all aspects of life. Extrapolating from the mad woman’s hysteria to unborn female foetuses, Da Rimini’s ghosts roam the web. Mimicking the behaviour of artificial intelligence, the ghosts are a combination of poetry and techne in which “all women are ghosts and should rightly be feared”, and “all history is pornography”. The emphasis on bodily fluids, orgasms and female genitals is a means to re-embody, reflesh and resexualize (male) dominance and resist the idea of cold and objective data. Rejoicing in the absurd, the ghosts embody the gender-specific and social power relations that are still present today. From the embodiment of exotic coloniality in *Bindigirl* (Prema Murthy, 1999) and the seemingly innocent yet disturbing character of *Mouchette* (mouchette.org by Martine Neddam, 1996), to the Instagram influencers of today, women still appear to be the Other.

It is important to make one final comment to this part. It is tempting to say that technology is easily employed to reinforce racism and patriarchy, capitalism and colonialism, thus aligning the dismissal of new media to the older trend of suspicion of technology that includes mechanisms, methods and scientific thought of the last 500 years. In a long line of scholars, Henri Bergson offered a theory of the comical as the “mechanical encrusted upon the living”, contrasting the vital and the mechanical, and Edmund Husserl was concerned with the “mathematisation of nature”, that is, the remaking of the lived world in the image of formal mathematical models that had been originally derived from or related to the world but come to objectify and subsume the world (Bergson 1914; [Husserl 1970](#b-9781474207935-020-0000085)). Here, in other words, the claim for transcendence of mathematics, made by Galileo and marking the beginning of modern science itself, leads to the superimposition of mathematical idealities over concrete things that are then made in their image. Decolonial scholars argued that certain philosophies of the Enlightenment propelled by modern science enabled dispossession of First Nations. Feminist scholars showed how women were identified with “bodies” and denied access to the activities of the “cogito”. Here, technology as part of modern science cannot escape rightful accusations. But the absurdism of the digital *does not rest entirely within the reductiveness of instrumentality, the violence of rationality or the objectification of the world*.

The scholarship of Donna Haraway, Katherine Hayles, Bernard Stiegler, Matthew Fuller, Laura Marks and many others offers an understanding of technology as co-constitutive of and with the human, as our politics, ecology, memory and architecture, part of our flesh, seeing, writing, stuff of cultures. Such co-constitution cuts across scales to arrive at a level if not of complete indifferentiation but undisentangleable forms of mutual informing. This view is cognizant of conflictual in-formation, of paradoxes, tensions, tears and catastrophes. It rebukes the attempts to put technology into a black box of seamless logic. Indeed, to talk about *incongruity of digital media is to discuss distancing and incomprehension, oddness and misfitting, ruptures and conflicts, mad intensifications, violence and glitches in all formations and at all scales*. These are incongruities not only between human and machine, body and mind, sensation and logic of code, but *within* humans and *within* the machines, within flesh and ideas, and within sensations and forms of rationality *as well as among them*. These are not incongruities between kinds of things, but within things themselves, in their hybrid technical, cultural, political and abstract formations.

In this way, digital media absurdism is a radically reconfigured and redefined but true descendant of the absurdism variously practised and theorized in the twentieth century.

## Form and Politics

Early absurdism, especially of Cabaret Voltaire, Tristan Tzara and Dada, has been linked to the First World War and the incongruity between political craftsmanship, on the one hand, and the massive loss of human life, on the other (e.g. [Lewer 2016](#b-9781474207935-020-0000091)). The mechanization of killing by early military technology kept becoming more “successful”, culminating in the Second World War (another atrocity placed at the heart of the Theatre of the Absurd). Here, the incongruity between the victory of secular rationality and the irrationality of the kinds of lives and deaths enforced by it graduates into a conflicted distance between, as [McLuhan (2001)](#b-9781474207935-020-0000100) put it, the man of action and the impossibility of taking action. Our current political modality is irresolvability, constructed following the invention of the nuclear bomb through the calculation of the strategies of deterrence ([Fuller and Goriunova 2019](#b-9781474207935-020-0000077)).

But it’s not only the imploding senselessness of possible total annihilation that is responsible for art’s absurdism. The early poetry of the absurd, including Guillaume Appolinaire, Alfred Jarry’s pataphysics, Tristan Tzara, some elements of Fluxus, and Soviet absurdists such as Daniil Kharms and Alexander Vvedensky, but also Andrei Platonov, framed absurdity through socio-political lenses, through reframing knowledges and ontologies, through a materialist Marxist approach to language, engagement with twentieth-century revolutions through class, artistic form and possibility of the future, among many other imperatives. Here again, we have conflicts and ruptures, incongruity between speeds of invention and adaptation, political demand and poetic work, social realities and possibilities.

The early new media art’s political context was the fall of the Berlin Wall, the collapse of the Soviet Union and the destruction of the bipolar global political order. Far from being a univocal victory of capitalism, it was an incredibly difficult time, of hope and the loss of hope, of orphaned political projects, unsolved problems and abandonment. Throughout the 1990s and early 2000s the political subjectivity to the East of Europe became one of dark ironic cynicism. We will be finding traces of this development throughout multiple projects sharing this existential inclination, both presented below and not included.

*Form Art* (Alexei Shulgin, 1997) in part was a response to the new HTML standard by the World Wide Web Consortium, which included “Form” components that allowed for basic interaction, that is, submitting data to the server. These all start, when writing HTML, with the <form> element: buttons and radio buttons, fieldsets, text areas, checkboxes. At the time of its creation in Budapest’s Center for Culture and Communication, C3, *Form Art* was partially a parody of this early interactivity. It also took stock of and utilized other, more habitual elements of HTML, such as scrolls, and, by thorough estrangement of the HTML form, it attempted to create a fresh language.

Exploring the full range of “form” elements, the title *Form Art* itself performs multiple tricks. First, it is a direct reference to the technical standard that is systematically explored. “Form” is also a loaded term in the history of art. Varvara Stepanova wrote, in 1921, that the fast-developing technological world in the conditions of revolution could not expect art to generate canonical forms (Stepanova [2021] [2016](#b-9781474207935-020-0000106): 853–60). The problem of form was moving outside of the realm of art, and the whole aesthetic approach to solving the problems of form was nothing but atavistic. Constructivism appraised the material foundations of form, but it also discredited the form as the focus. What mattered was 1) the production process that gave rise to the object’s form, and 2) the produced object’s principle of use. Form itself, said Stepanova, was to become a principle of continual change. What do we make of these in relation to *Form Art*? The form under exploration in *Form Art* has not come from art, as the objects of Stepanova’s critique. It is a technical standard inherited from the paper office and borne by the capabilities of the scripting language, such as HTML. Yet it is the aesthetic form of the new screen, such as the computer screen and the window of the web browser. In this post-constructivist condition of a form borne by the practical use and the larger technical process, what is art’s function, where is art’s work?

Ben Lerner says that the problem of poetry is that people expect too much of poetry and it always falls short of expectations ([Lerner 2016](#b-9781474207935-020-0000088)). Poetry inevitably falls short of the impact Plato attributed to it in the *Republic*: a world-transforming impact. Art has a similar problem. *Form Art* a priori falls short of art, of our imagination and expectation of art. Sea waves made of jumping radio buttons? *Form Art* is a depiction of a dead end in the middle of what we are presented with as the highway into the bright future of collaborative knowledge and creativity. The rupture of absurdism is right here.

Computational culture lacks interesting forms of visibility. The visual form of the advanced technical culture of the 1990s was meagre; today it is not much better. What is the visual language of Facebook, Twitter, Google? Of dull data visualizations? With interesting exceptions, such as in architecture, dance or textiles, new media is still square and it knows it. Hence, it attempts to disappear (become a brain implant, a glass interface), become a frame (ugly VR headset that can’t be seen once it’s on), get out of the focus. Transparency is the aim of new media. How can the art of transparent media possibly look and feel? If the material is invisible or so poor that it is as good as invisible, which forms can we attempt to liberate and for what purpose?

*Form Art* makes, out of boxes and radio buttons, of fieldsets and text areas, little human figures, flags, cars, tanks, ships, smoke, snow, trees, dogs, cigarettes, letters. Why these things? They send us back to bureaucracy, industrial design, factory and office work, the state, the spectacle, “normal life”. It feels like whatever trash is abundant in our visual culture comes out, because it doesn’t find any resistance, anything more interesting to keep it suppressed. The project estranges the forms but doesn’t construct an alternative reality, doesn’t make a socio-political proposition. In doing so, its funny side appears very dark. While removing instrumentality, it doesn’t give anything worthy in return. Four unfillable text areas make a window? This is despair masked as a joke.

Perhaps it is also a conflict between the childlike drawn figurines, plain pictorial signs, forms stripped to basic geometric abstractions of line or algebraic forms of the table, on the one hand, and their relentless power, on the other, that is at the core of this project. Excessive power is absurd. Taking on the powerful is a strong undercurrent in media art which could be described in two ways. One is about anti-art and an ethos of institutional critique, with artists attacking established figures and the idea of hierarchy in art. Eva & Franco Mattes copying and republishing art sites (*Copies*, 1999) in the beginning of their career is a prime example here. The gifted computer programmer, polemic artist and provocative critic of capitalism and fascism, as well as marketeer, Netochka Nezvanova managed to become a legend in early net art circles by writing endless poetry/spam entries in a number of mailing lists up to the point of being expelled. While others, such as Mez and Igor Štromajer, also created their own net-speak or code-poetry, Netochka’s messages—usually a mixture of the Latin alphabet and ASCII signs interspersed with coding—ranged from the cryptic to being illegible, factious and rebellious.

Another line of engagement is a more explicitly politically defined media activist work. Ranging from questions of collective authorship, anonymity and political action under the Luther Blissett pseudonym, to the work of Amy Alexander, who wrote software to enable media activists to effectively copy and track amendments to corporate websites, artists and activists intervened in media communications streams, political structures and material cultures to produce alternative narratives, possibilities and realities. Amy Alexander’s *CueJack* (1998) was a scanner that, like a camera scanning a QR code today, would lead to a web page with truthful information about the product’s origin and production process. Her software was used by the Yes Men in 2000 to create a fake GATT website (now the World Trade Organization), which looked like the original website but hosted revealing information about the organization’s activity. This was prior to the Google rule which meant that a “corrected” website was not only findable but could on occasion be displayed as the top search result and users could locate a get-in-touch email without having looked at the site’s content. Indeed, one of its unintended consequences was the Yes Men starting to receive invitations to speak at conferences and to the media as representatives of the WTO. They thoroughly employed classical absurdity in their presentations, hoping to shock conference participants and cause media storms. A prank at the “Textiles of the Future” Conference in Tampere, Finland (2003), for instance, featured calculations of affordability of contemporary slave-keeping versus outsourcing labour to the Global South as well as the speaker removing his suit and revealing a golden bodycon overall with a body-length inflatable phallus/interface device to control remote workers. Not that it really shocked anyone.

Absurdism, which acquired new tastes and scale of visibility with new media, was an effective political tool throughout the 1990s and 2000s and also generated a number of viral and notable aesthetic events, from surfing clubs to cultures of web design (such as You’re The Man Now Dog or YTMND see [Goriunova 2012](#b-9781474207935-020-0000080), culminating in memes. It was then weaponized by the corporate capitalists as well as the alt-right, especially in the wake of the campaign for Trump’s presidency. The incongruity at the basis of new media absurdism, coupled with nihilism, proved not to be immune to exploitation by white supremacists These groups learned to utilize estrangement, experimentation with form and construction and other aesthetic devices of counterculture very well.

Work by the Yes Men rests on a long tradition of culture jamming and political disobedience that takes on the absurd to enable non-violent protest and oppose the no-escape/no-future narrative propelled by the status quo. If we indeed, as Mark Fisher reported, find it harder to imagine an end to capitalism than an end to life, isn’t it thoroughly absurd ([Fisher 2010](#b-9781474207935-020-0000074): 2)? With capitalism graduating into the order of life itself, twentieth-century metaphysical absurdism, including existentialism, takes on a new meaning. Camus framed it as the “divorce between man and his life, the actor and his setting, [which] truly constitutes the feeling of Absurdity” ([Camus 1942](#b-9781474207935-020-0000066)). The discord of human life composed of impossibility, irresolvability, disadjustment, misalignment, slow and fast violence and endless destruction is a transcendental expansion on the much earlier ontological ordering devices of the carnivalesque that historically underpinned absurdism. The capsizing of the divine or feudal ordering of the carnivalesque gives way to the non-sense of capitalist structuring of the unipolar world without alternatives—*an absurd world.*

## Systems and Infrastructures

The question of form in relation to politics, one of the core themes of twentieth-century art, as we have seen, takes on new and multiple meanings in new media art. Not only a question of direct action and intervention, or appropriation and counter-attack, the destabilization of art institutions, anti-art, non-art and automated curating, it also concerns itself with computational forms, such as databases or machine learning models, and cloud infrastructures, investigating politics and aesthetics of expanded computational systems. *Absurdism here can be used as a method or arise as an effect of human–computer interactions.* At times embraced as a preferred aesthetic, it often takes on a capacity to frame or otherwise systematize a complex set of affairs.

Digital media art not only queried art systems and computational infrastructures, but also created them. The irregularity of new media art was maintained by a consistent line of work aimed at creating platforms and drawing in people and projects from outside of the field of art. Exemplified by *Refresh* (1996), a defunct project which consisted of pages distributed between geographically dispersed organizations and their servers, and the First Cyberfeminist International platform organized by the Old Boys Network as part of Documenta X (1997), new media art developed infrastructures with a view to inclusion of a large amount of voices. Part of this movement was reconceptualizing non-art as art. The Runme.org software art repository featured a “digital folk and artisanship” category, hosting a number of “*objet trouvé*” projects fished for in the debris of networks. Such folklore was exemplified by anonymous software ephemera, such as virus-like minor prank programs of the 1990s, Easter eggs, various ASCII art traditions, a hackers’ “canon” of pranks and cool things.

*WinGluk Builder* (2002) by an anonymous author, for instance, is a collection of pseudo-viruses and a tool for building them. The project is representative of the cracker culture of “revenge software” that produces the impression that the computer is affected by a virus. Running the program would crumble the icons or make the screen blink in every colour it can produce. But as an ironic metacommentary on the all-powerful cracker culture, *WinGluk Builder* is also a program for custom making such “viruses” for users’ own disposal via specifying, through a menu, the effects one wants to produce and simply pressing the “generate” button. The project also makes fun of the Windows-like standard application interface that, coupled with a mockery of functionality, makes aesthetic interventions into software design and functionality from niches buried deep in the “dark” web.

Another example is *Tempest for Eliza* (2001) by Eric Thiele. *Tempest for Eliza* is a computer program that uses the capacity of a cathode-ray tube computer monitor to send out AM radio signals to transmit a piece of music. Any cathode-ray computer monitor was constantly sending out high-frequency electromagnetic waves that could be caught by short wave AM radio. Thiele wrote a program that displayed such images on the monitor’s screen (black-and-white stripes) that translated into the waves of “Für Elise” by Ludwig van Beethoven, which can be caught and played by a radio put nearby. The program is “proof” of the possibility of spying on computer users from a distance. The *Tempest* was exhibited, among others, at one of the Readme software art festivals, in Helsinki. It was an absurd sight. The transformation of the monitor designed for visual display onto the radio-emitting station designed for the ear was crowned with Beethoven’s classical melody performed in a low-tech, crackly way. There was nothing else but black-and-white lines, transmitting one of the most recognizable melodies of romantic music. The absurdist incongruity between the basic geometry of blocks displayed on the screen and the romantic melody perceived by ear underlined the sheer rapacity of technology that could be processing anything at all but would still look like a bunch of black-and-white stripes.

Erica Scourti has become known for her performative projects based on her online life, which include prodding and pushing software systems and their analytical capacities, such as predictive computing. From asking a ghostwriter to write her biography based on her online traces in social media, email accounts and search history (*The Outage*, 2014) to collating fragments (from her online archive parsed by algorithms or semi-automated editing systems) and commissioning others to imagine the missing links to create short stories about her life (*Dark* *Archives*, 2015), Scourti staged process-led scenarios in which human and computer intermingle and form a collaborative authorship, and where it is never fully clear who the actor is and what is influenced by whom. Scourti’s emphasis on automation and machine learning in meaning making is visible in *Slip* *Tongue* (2018), which is structured around snippets of personal exchanges with friends and family that are edited and read randomly by a voice imitation algorithm. Scourti works with predictive text or image sorting and recognition systems, but every time the result has a haunting sense of absurdism about it. Countering the presumed clarity and objectivity of technology, Scourti emphasizes the fragmentation, noise and slack performance of computational processes. While exhibiting a profound interest in the working of computational infrastructures, she never lets them remain abstract. Operating in this mix of her own experiences and (digital) memorabilia with abstract computer protocols that are unstable and liable to fail, her performances unfold to become—with time—increasingly absurd.

In *Life* *in* *AdWords* (2012–13), over a period of nearly a year Scourti emailed her diary to herself via her Gmail account, and each day read aloud, in front of a webcam, the keywords that Google came up with. This length of time gives these daily performances an emotional and poetic quality that is stoic, ironic and absurd. Using her private everyday self as a site for artistic experimentation and expression, Scourti takes pleasure in the confusion of boundaries, whether of language and fiction or body and identity. While where the artistic and private life begin or end is never really clear, Scourti’s semi-autobiographical poetic gestures can seem compulsive in the social media machine of self-branding. This is not only true for herself, but also for her friends and family, whose personal exchanges can become part of her work. It could be argued that these tactics merely play into the mechanisms of neoliberal capitalism and thus reinforce the power dynamics at play. While being very aware of these implications, Scourti shows how, by an intensive scrutiny of different roles and functions and by the application of tactics of exaggeration and extreme appropriation, dealing with the rules can actually empower. Her method is strategic: by using technical translations and filling the gaps with fiction, fragments of videos, photos or drawings, she enacts an absurdist aesthetics which emphasizes the socio-political implications of personal data being filtered, analysed, fed forward and backward propagated. Performing with the algorithms, bots and other automated intelligent systems in an absurdist way ultimately underlines *the absurdism of Big Data promises and the absurd lure of artificial intelligence*.

Why not begin a countermove by setting up your own big tech company, DullTech™ (2015)? Constant Dullaart is known for his exploration and subversion of the web as a medium of communication and distribution, in particular in relation to its technological and socio-political constraints and affordances. While playing with his often misspelled or misunderstood Dutch first and family name, Dullaart, which is not a portmanteau word (i.e. constant dull art), he manages to bring dullness to the next level. Dullaart embraces and enacts the Dull as a performative act in the form of a real-world start-up DullTech™. Both a performance and a genuine hardware start-up DullTech created technically simplified—or dull—products, which evolved into dull.life™. DullTech is also an “accelerating incubator environment” that serves as a commercial co-working space and a physical platform. Gaining access to, or becoming part of, the corporate tech worlds meant, for Dullaart, operating within their stratification system. This included hanging around trade fairs and chatting on QQ (a social messaging service in China), posing as a businessman while trying to get in touch with producers who were “off their heads with meetings” and finally visiting the factory, figuring out import duties and designing the products. The brand evolved into DullCloud, DullBrown, DullDawn, DullSocial, DullDream and dull.life™ as it continued its metonymic narrative.

Absurd inhabitation of the dominant techno-economic orderings, from the social mingling of the fairs to the bureaucracy of the office, and from the industrial order to inverted libidinal machines, was followed, for Dullaart, by other forms of absurdity. With *Phantom Love* (2017) Dullaart turned to poetry and language as a means to disrupt the conventional use of social media platforms, this time targeting Instagram. Although his main criticism was focused on commercialization and standardization through aesthetic appropriation and performance, he also directed his attention to the users of these platforms. In a series of five performances, Dullaart uploaded lines of poetry to the Instagram accounts of semi-public organizations. Helped by an “army” of Instagram accounts, several artificially constructed identities were made to recite the poems. Each account delivered one line in turn as comments to a posted image.

*Phantom* *Love* amplified several politically questionable Instagram accounts: the public organizations of the EU Council, US Customs Border Protection, Historic Green-Wood Cemetery, Department of Homeland Security and the Internet Society, an American non-profit that provides leadership in internet-related standards, education, access and policy. All of them seemed to seek validation from their “audience” via their Instagram accounts. The fictitious accounts were used as new tools and actors for communication, albeit in ambiguous and disconcerting ways. At first sight the comments seemed random, nonsensical and trivial. For example, the first two comments responding to an image posted by the Department of Homeland Security resembled regular responses—a critical and a positive reflection on the initial post—yet the third comment was more cryptic, “cesarsantana420 to know ones way around”, and it was followed by another fifty or so arbitrary sentences. Or so it seemed. Reading one after the other created a strict and consistent pattern. A rhythm emerged and a narrative unfolded.

While Dullaart lets his “forces” recite, the stanza is coloured by either a militant or a techno-utopian dimension, and a chorus develops which is at once nonsensical and sensible, social and technical, a prank and a political statement. While the first poems still follow a functional cadence and rhyme, the later ones are increasingly complex: interspersed with additional punctuation marks, abstract symbols and emojis, creating visual patterns as well as signalling the often automated nonsensical response mechanisms on social media, and using words from different languages to create double meanings and confuse: for instance, “kind” (English) and “kind” (Dutch, for a child). To find out what is happening in Dullaart’s poems requires a close reading: who or what is speaking, what or who is spoken about, and how the comments relate to each other and to the main account. In the process, the reader becomes immersed in the intermingled identities and voices; some of them human while others are propelled by technology. Although Dullaart is not interested in writing computer-generated poetry, the technical aspect of word exhibition is nevertheless an important part of the work, and in particular the question of how artificial identities are created and intercepted or not, and thus affect the meaning and context of the poem. The material is both tool and content. Indeed, while Dullaart made a strict protocol for the “armies”, what actually happens is that each line needs to be logged manually, and one follows the other after it has been validated. Yet it may happen that the verification comment comes later than expected and someone has already pushed the button twice. So, the same line might appear suddenly in two different accounts. However, inevitably, the rhythm and content will change as identities are unmasked, either because they are discovered as fake or because the owner discovers that her account is being used in ways she doesn’t like. The latter, also known as a “stealth account”, emphasizes how identity is often not clear and can be used in ambiguous ways. Similarly, in *Phantom* *Love* the distinction between real and fake accounts is not straightforward: while Dullaart instigated the process, the technical machine performs—or conducts—the outcome, at times interrupted by human input. Moreover, the poems were released anonymously, and although one is signed at the bottom and Dullaart revealed his authorship after a while, most users will likely have been puzzled as to what happened: Are the poems idiocy, a critique or praise? The regularity of the stanzas and the irregularity of the words and symbols, the formal instruction versus the mechanical randomness, and the ambiguous use of identities, infused by computational processes, make the poems expand beyond themselves, creating multiple readings and understandings.

By undermining the fundamental structures of the platform and subverting the “like” economy through the practice of commenting, Dullaart manages to create confusion, if only for an “Instagram moment”. That these moments don’t last is not lost on Dullaart. The domain name [<http://www.attention.rip/>](http://www.attention.rip/) and the tag #attentionrip are the preambles for the day the predictable will happen: the accounts will be identified and subsequently shut down. In an attempt to save the performance Dullaart recorded the entries via webrecorder.io, where they can be read in full, albeit the immediate surprise of the sudden encounter (in many accounts one post is liked many times more than others) and thus its tactical appeal is lost. Dullaart’s poetry alienates its form, the context in which it performs, interweaving and estranging the technical, human and the social media platform. The alienation is where absurdism is resurrected.

Systems, whether seemingly natural (such as language), or ostensibly hierarchical (such as “the art world”), orderly (such as bureaucracy) or messy but often working (such as image recognition software, and infrastructures, including global distribution of goods or labour, cloud computing, as well as forces and movements, of capital and political power) are difficult to take on. As it is often not possible to meaningfully step outside of them, taking on systems and infrastructures has to rely, at least partially, but inescapably, on formulations and enactments on their own terms. Similarly to how language delineates expressability, and objections to language are formulated in language, disturbance comes from within. *The moment of the absurd is the breaking down of completeness, success and seamless capture.* Kurt Gödel’s theorems of incompleteness, proving that any formal consistent system will always have statements unprovable within the system, led to Alan Turing’s exploration of the halting problem, which he solved with the invention of the Turing machine—the foundation of today’s computer. *What if the rupture and incongruence of absurdity is at the heart of the digital machine?*

## Conclusion

What digital media absurdism does to twentieth-century absurd is to broaden it, simultaneously abstract and materialize it, globalize it, make it a platform and dehumanize it. Twentieth-century absurdism was partially rooted in the anguish of humanism and the realization of its limits, the collapse of the subject and the focus on the materialist forces of transformation. As the notions of the worthy subjects are expanded, through struggle, to include non-male, non-white, non-human, the logic of the absurd widens. The absurd concerns meaning and evolution; cells, immune systems and colonialism; bodies, affect and algorithms; violence and global infrastructures. Hence, the absurd is not pinned on a “versus”—humans vs technology, sense vs code, irrationality vs instrumentality—but on incongruities of a “within”.

Digital media and their computational processes affect lived time and reconfigure space. Digital mediation allows for zooming in on minuscule ruptures as well as zooming out to joined calculative efforts. The digital scales very well. It has the capacity to intervene before one’s consciousness can register it as well as drive one insane by service requests. It is the technology of the affect. It is the renewed constructor of race. It is the logic of governance. It is in our bodies. It can operate globally in the cloud, solving problems and creating problems. It is the future of intelligence and war. It is a new instrument through which everything looks to be made differently.

The digital absurd is the distance, discord and incongruity that appear through the new look, everywhere you look. The digital media absurd utilizes and builds on the devices employed by the absurd before it: sarcasm and parody, jester performance and trickstery, nihilism and ache, illogical sequences of actions/narrations/images, clashing registers of knowledge, breakages, context swap, shock, but it also develops new forms for the absurd. These include the total archiving and the madness of data, technological infrastructure as a failing artistic material, despair of form, kidnapping content and many others.

We have not mentioned even one per cent of projects warranting inclusion here. We could have written about the dadaistic, vanishing digital in the Museum of Ordure (Geoff Cox, Stuart Brisley and Adrian Ward, 2001). More could have been said about the absurdity of automation, both in terms of identity (Cornelia Sollfrank, *Female Extension*, 1998) and infrastructural form (JODI, *GEO GOO*, 2008; Igor Štromajer, *101 Algorithmic Computer-Generated Pseudo-Poems*, 2020; Matthew Plummer-Fernandez, *Novice Art Blogger*, 2014). We have deleted a whole section on database absurdity as the article got too long (Olia Lialina, *My Boyfriend Came Back from the War*, 1996 and Sakrowski, *Curating YouTube*, 2007). Very little was said on absurdity as trickstery and parody (Janus Janus Janus; etoy; UBERMORGEN). Many more examples of alternative art organizations and platforms could have been included (F.A.T. Lab, Van Gogh TV and others) as well as interventions into corporate giants and new machine learning systems (Aaron Koblin, *The Sheep Market*, 2006). Performances of idiocy and absurdist interventions into software systems such as social media, maps and video hosting platforms could be further investigated (Petra Cortright, *VVEBCAM*, 2007; Rosie Gibbens, *Micro-performance*s, 2021; Ogmios, *School of Zen Motoring*, 2020). Complex investigations of systems, including ecological, mystical, political, sexual and their intertwinement with the digital warranted a section (work by Heath Bunting, Martin Howse, Shu Lea Cheang). However, having reached the word limit, we have to stop writing. After all, isn’t it absurd to write about the absurd?

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Tactical Media are what happens when the cheap ‘do it yourself’ media, made possible by the revolution in consumer electronics and expanded forms of distribution (from public access cable to the internet), are exploited by groups and individuals who feel aggrieved by or excluded from the wider culture.

— [David Garcia and Geert Lovink (1997)](#b-9781474207935-021-0000159)

Tactical Media was a movement combining art, experimental media and political activism that shone brightly during the 1990s and whose influence continues to resonate. Although present around the world in various forms since the birth of modern communications, it was first identified and named in Amsterdam through its association with “The Next 5 Minutes”, a series of politically inflected media arts festivals.

The movement reached critical mass in the 1990s in part through a revolution in consumer electronics in which the easy availability of devices such as the camcorder and PCs allowed a new breed of media makers to occupy the cracks that had started to appear in the monolithic edifice of mainstream media.

Tactical Media had a number of key methods and principles but at its heart was a single axiomatic directive: no bystanders. The mere act of holding a camera and a microphone would no longer be enough to place the media maker outside of the action. For Tactical Media, neutrality was never an option, “everyone who is present is expected to be active”. It was, above all, this principle that gave new urgency to the ideal that mass participation should take the place of spectatorship. Although the participatory ideal is increasingly contested it has deep roots for those who retain expectations of wider democratic engagement.

This article not only tells the story of the movement’s emergence; it also argues that Tactical Media only matters because, from its inception, it carried a distinctive combination of methods for the effective mixing of art and politics from which today’s artists and activists can still learn. I am arguing that Tactical Media not only anticipated the *social turn* in art; it should also be understood as a re-specification of the art of political campaigning itself.

The arguments set out here are woven into a rough timeline that marks out some of the significant influences and events leading to the movement’s crystallization in 1990s Amsterdam. It will include the influence of the Dutch squatting movement, the distinctive local technical infrastructure, the general character of the City of Amsterdam, the Next 5 Minutes series of Tactical Media festivals, the role of Paradiso and other key institutions, the influence of the AIDS Coalition to Unleash Power (ACT UP) and of Michel de Certeau’s *The Practice of Everyday Life*, a book that introduced the relevant use of the term “tactical”. It will include a summary of critical perspectives and will conclude by pointing to some of the contemporary formations exhibiting characteristics and legacies of Tactical Media, notably image boards such as 4Chan that spawned the movements Anonymous, and the Alt-right alongside their polemical opponents the Evidential Realists.

## Big Picture Background

Although Tactical Media is frequently associated with a particular group of artists, namely Critical Art Ensemble (CAE), ®TMark, the Yes Men, Bureau of Applied Autonomy and the Electronic Disturbance Theater (EDT), the actual breadth and reach of the movement is far wider. As the artist Paul Garrin argued, “as a movement it was not invented but only named” and could be seen as encompassing a host of related practices such as hacktivism, culture jamming, pranking, subvertising to name but a few. But for better and for worse the broader and more inclusive term “Tactical Media” was first coined in Amsterdam in the early 1990s and associated with “The Next 5 Minutes” series of media arts festivals organized by an unruly alliance of artists, former squatters, media pirates and theorists.

The ideals of the early phase of this movement cannot be separated from the geopolitical circumstances that followed the collapse of the Soviet empire. The association of this moment with a radical change in telecommunications can be detected as late as 1999 when in his Reith Lecture sociologist Anthony Giddens could still confidently assert that “the information monopoly, upon which the political system was based, had no future in an intrinsically open framework of global communications” ([2011](#b-9781474207935-021-0000161): 72–3). Throughout this decade it seemed as though old-style armed insurrection had been superseded by digital dissent and media revolutions. It seemed as if the samizdat spirit extended and intensified by the proliferation of do-it-yourself media, had rendered the centralised statist tyrannies of the Soviet Union untenable. Some of us allowed ourselves to believe that it would only be a matter of time before the same forces would challenge our own tired and tarnished oligarchies.

The belief that electronic media could be instrumental in democratizing both culture and wider society can be traced at least as far back as Brecht’s lecture on “The Radio as an Apparatus of Communication” in which he famously described radio as the “finest possible communication apparatus in public life, a vast network of pipes. That is to say it would be if it knew how to receive as well as to transmit, how to let the listener speak as well as hear, how to bring him into a relationship instead of isolating him” (Brecht and Silberman 2011: 42). This dream of mass cognitive mobilization leading to the rise of a mass intelligentsia has always been a thread running through the modernism.

## Amsterdam’s Fertile Soil

Entangled with the geopolitics were a set of equally important local factors that shaped the manner in which the concept of Tactical Media emerged. This in part was founded on the character and atmosphere of the city of Amsterdam, a unique metropolis that combined the multilingual intensity of a capital city with the intimate scale of a small town. In many ways it was and remains the archetypal “global village”. Elsewhere I have called Amsterdam a pirate utopia for tactical media.

Another reason the city proved to be such fertile soil was its distinctive media infrastructure. The Netherlands was the first to fully integrated cable TV and radio networks in Europe. But it was the municipality of Amsterdam that added a well-provisioned public access service in which anyone with the basic technical capability could make programmes reaching the population of the whole city, conditions that allowed artists, social activists, squatters and media pirates a space in the media landscape for almost limitless experimentation.

In addition to the technical infrastructure was a combination of cultural and societal factors. From an ideological standpoint the most important of these was the “radical pragmatism” of the Dutch squatter’s movement. At its height organizers could mobilize thousands of protesters to protect any threatened squat. But the Dutch squatters represented far more than the issue of housing. And from the wider social perspective the movement effectively challenged mainstream culture by creating a parallel and self-contained social world that included squatted bars, clubs, cheap eateries, ambitious galleries, printed magazines and above all pirate radio and TV.

Alongside, and often overlapping with the squatters, was Amsterdam’s lively art scene that included many international artists who benefitted from what was in those days a welcoming atmosphere. This positive ethos was sustained by a number of adventurous and well-resourced cultural institutions willing to take risks and blur where the boundaries of art practice should lie. These included Time-Based Arts, De Balie, Melkweg and later V2 (the Centre for Unstable Media) in Rotterdam, all of which were involved in co-hosting the Next 5 Minutes festivals of Tactical Media. But during the initial developmental phase of the movement, the most important institutional player was the legendary pop venue the Paradiso, a large, converted church in the centre of the city.

## Paradiso

At the tail end of the 1980s alongside its music programme the Paradiso began a series of experiments in public discourse that (over a highly productive decade) played an important role in laying the foundations for Tactical Media.

Paradiso’s unique position was in large part the work of one of the producers, Caroline Nevejan, whose stated ambition was to reimagine “public debate as popular culture”. The first of a number of watershed events was the Galactic Hacker Party (1989), the first large-scale European venue that took the risk of bringing together computer hackers from around the world in a programme of workshops and events. The event took hacking beyond the stigma of clichéd scare stories. It also took hackers seriously as a community and an important subculture on the threshold of becoming a wider social and political movement. The event received a significant amount of national and international attention.

## The Seropositive Ball

A year later Nevejan sought to build on the success of the hackers’ party by connecting the local networks of hacking expertise into a concrete political cause or campaign. At a point when the AIDS pandemic was still raging Nevejan initiated “the Seropositive Ball”, a 69-hour live event of art, activism and public debate conceived initially as a shadow meeting to the world’s AIDS Conference in San Francisco.

The Seropositive Ball team succeeded in bringing to Amsterdam many of the most dynamic artists and activists associated with AIDS activism including members of Gran Fury, Gregg Bordowitz, Jean Carlomusto, from the Testing the Limits video collective, renowned filmmaker Marlon Riggs, and Adam Ralston and Alexis Danzig to name but a few. On the Amsterdam side Dutch media artists, activists and performing artists worked alongside local hackers to set up a communications infrastructure enabling those too sick to attend some level of engagement. A remarkable application was created by developer Rolf Pixley that was designed to access the internet with an easy-to-use interface that worked by clicking on screen buttons with a cursor. It used HyperCard to bypass the cumbersome Unix command protocols of the time and thus created a browser-like interface long before the browsers that would become the World Wide Web.

The encounter between local activists and visitors from New York’s AIDS Coalition to Unleash Power (ACT UP) not only exposed the Amsterdam activists to an entirely different level of intensity but the Seropositive Ball constituted some of the key foundation blocks of Tactical Media.

It is a sobering thought that the lessons many of us learned from ACT UP came at such a high price. ACT UP campaigners were often “working against the clock to try to save their own lives”. There was no time for strategic deliberation. For this extraordinary generation tactics were the only option.

## Let the Record Show

ACT UP’s existential urgency brought into being a number of methodological gains. These included a new *role for art,* the *no* *bystanders* principle, a bias towards *simultaneity over consensus* in decision making, and a belief that *action* should precede giving rise to theory, inverting the Gramscian principle of praxis in which theory is present but emerges from action. These principles are set out in Sarah Schulman’s remarkable book *Let the Record Show: A Political History of ACT UP New York,* *1987–1983*.

## Art

The importance that art had for ACT UP is reflected in the book’s headline title, “Let the Record Show”. This refers to an installation shown in the front window of the New Museum in SoHo in 1987/8. It took the form of a layered montage with images associating the Seropositive Ball hostile socio-political actors of the time with the war criminals tried at Nuremberg. The work was by the artists’ collective that later became Gran Fury and was also the group who designed the famous Silence = Death logo that became the visual calling card for global AIDS activism.

Schulman goes so far as to contend that for ACT UP “cultural production was indivisible from its other campaigning activities”, making the claim that “ACT UP was probably the first movement of deeply oppressed people whose lives were at stake to have included such a large group of designers, advertising professionals, studio artists, marketeers, and publicists” ([Schulman 2021](#b-9781474207935-021-0000178): 317).

The role of visual art in the movement and the impact of ACT UP’s innovations in transforming art itself were highlighted by the publication of a special AIDS edition of the journal *October* in 1987, edited by the influential critic Douglas Crimp. Crimp’s introduction sought to deconstruct the many well-meaning attempts by artists who were addressing the pandemic with artworks whose primary function was the “creation of consoling transcendental spaces”—a focus which as Crimp points out consistently overlooks art’s potential as a form of activism and as a means to mobilize affective energies.

## No Bystanders

The principal directive, *no bystanders*, is best expressed through a revealing anecdote in which two artists, David Meieran and Gregg Bordowitz, arrived at one of the legendary Monday-night ACT UP meetings, carrying video cameras and presenting themselves as traditional “documentarians”. They were taken aback when ACT UP founder Larry Kramer had no interest in being interviewed and no one at the meeting actually wanted to let them record there at all.

Meieran and Bordowitz soon realized their mistake had been a failure to conceptualize themselves as part of the action. Everyone present was expected to be active. Meieran and Bordowitz’s response was to establish the “Testing the Limits” video collective that set out to record every ACT UP action, but from the inside. They established a conceptual role for video as part of the movement. They soon moved from stand-alone videos alone to tactical television as Bordowitz, working with Jean Carlomusto, produced “The Gay Men’s Health Crisis” cable TV programmes.

## Simultaneity Not Consensus

Another key innovation with “tactical” implications was the organizational principle of *simultaneity not consensus*. This was an implicit decision-making process that evolved as a way of avoiding time-wasting disagreements. It was an approach that allowed many, different expressions of direct action to be carried on simultaneously without having to establish “full consensus, total participation or universal agreement. The only requirement was that it was direct action, with a goal related to ending the AIDS crisis” ([Schulman 2021](#b-9781474207935-021-0000178): 28). It “allowed for a wide range of simultaneous responses, in multiple social milieus, with different concrete aims and involving different targets and participants” (ibid.: 30).

## Amsterdam Confrontation

In theory the meeting between Amsterdam’s grass-roots experimental media culture with ACT UP’s passionate and media-savvy activism should have given rise to a unique set of synergies but instead there was a painful but instructive philosophical clash. The substance of this confrontation is best captured by an intervention in the culminating debate by the artist Gregg Bordowitz, one of the most influential cultural activists of his generation:

I came to this event looking for common interests based on the specificities of our experiences. But the way this conference is organized is based on a utopian notion of the free exchange of information. Instituted through technology. A use of technology that is unquestioned, uncriticized, unproblematized. Driven by a notion that a universal space can be established through phone links, faxes and modems. If there is one thing that is established through the kind of work, we do is that there are no such things as any universal categories, principles or experiences … There have been many times when technology has been used for technology’s sake. I have often felt trapped in a technological formalism.

— ([Bordowitz 1990](#b-9781474207935-021-0000134): 108)

As organizers we were taken aback by Bordowitz’s assertion that we were succumbing to a new formalism and the delusion of the new media sphere as “a universal space of free exchange” in which complex problems are seen as susceptible to a technological fix. Bordowitz’s critique is as potent today as it was to the hacker culture of the 1990s. But still the Amsterdam network persisted in the view that the New York activists could not simply overlook the importance of the material and cultural impact of powerful new technological infrastructures that were coming into being. We had to engage if we were to resist.

## Tactical Television

The need to explore these dilemmas on a much wider canvas than a single campaign gave rise to the first edition of the Next 5 Minutes festival (N5M) in 1993. It was a recognition that groups such as Testing the Limits were part of a global explosion of “tactical television”, DIY TV making that was crossing the borders that once separated mainstream from alternative media. Bas Raijmakers, one of the organizers of the first Next 5 Minutes festival of “Tactical Television”, wrote of a “new generation sharing the common social and cultural position of having no fixed institutional or discursive relationship with the world of television” (in [Van Bergejik and Van Dijk 1992](#b-9781474207935-021-0000191): 8). Raijmakers went on to describe how these new spaces that allowed for new media practices to flourish were enabled by a number of factors. To begin with a consumer electronics revolution had created cheap and easy-to-use production tools, most notably the camcorder and PC, not to mention the accelerated growth in the number of channels and the opportunities that cable networks and satellites offered. Furthermore, there was rapid diversification among TV audiences as the multiple cultures demanded representation.

## The Long Video Moment

Quite apart from new modes of distribution there was also a more material aspect of video that made it a defining enabler of Tactical Media’s early phase. Unlike the grandiose museum-based art installations of the 1980s the arrival of new portable flexible devices, notably the camcorder, allowed for a fresh engagement with video’s intrinsic quality of “liveness”, its quality of forensic immediacy. Once video stepped beyond the broadcast studios in the 1960s its impact and distinctive attributes were immediately apparent well beyond the worlds of art and media.

The introduction of video has been recognized as being as important to the behavioural and social sciences as the microscope was to the life sciences. The medium has a unique ability to analyse and instantly replay the tiniest nuances of behaviour on a variety of scales. From the movements of crowds to the tracking of the eye movements of infants, complex behaviour could be captured, tracked and analysed in real time as never before. Video was the first audio-visual medium to collapse the capture, management and dissemination of data into a single action, creating a bridge between art and research whose implications are still being explored by artists to this day.

## Michel De Certeau

The specific usage of the word “tactical” in Tactical Media was taken from Michel de Certeau’s *The Practice of Everyday Life* (1984), a book which explored the multiplicity of ways in which the products of daily life are creatively appropriated and repurposed by consumers. Writing in the 1970s de Certeau deployed the term “user” interchangeably with “consumer”. It emphasized the fact that subjects were not merely passive recipients of cultural products but active and sometimes rebellious partners in the creation of meaning. It was de Certeau who pioneered concepts that would later be repurposed by the tech companies under the rubric of terms such as “co-creation”, “user-generated content” and “citizen’s journalism”. But critically de Certeau, writing a full decade before the mass popularization of the internet, never succumbed to the illusion that the partnership was an equal one.

*The Practice of Everyday Life* appeared at a time when the landscape of critical theory was still dominated by methods and practices of semiotics and cultural studies which typically involved the critical decoding of texts. In place of these methods of a politics of image and representation de Certeau emphasized not so much the meaning as the *uses* of representations as he sought to account for the multiple ways in which the weak turn the tables on the strong. This shift in emphasis from representation to its uses can be detected in the very first sentence of the book’s introduction, in which he characterizes the enterprise as a “continuing investigation of the ways *users*—commonly assumed to be passive and guided by established rules—operate” ([de Certeau [1984] 2011](#b-9781474207935-021-0000156): xi, emphasis added).

Thus, he signalled the need for a less deterministic and more dynamic depiction of cultural politics. In the Amsterdam of the 1990s the artists and thinkers associated with Tactical Media took inspiration from de Certeau’s rich and subtle language of tactics and strategy, detecting within its detail and operational granularity a kind of *user language* for cultural resistance and renewal. It suggested a way of engaging with a new kind of political economy.

At the heart of de Certeau’s theorizing is the distinction between tactics and strategy ([[1984](#b-9781474207935-021-0000156)] [2011](#b-9781474207935-021-0000156): xix). The strategic is characterized as “a calculus of force relationships when a subject of will and power (a proprietor, an enterprise, a city, a scientific institution) can be isolated from an ‘environment’”, a place where it can “capitalize on its advantages, prepare its expansions, and secure independence with respect to circumstances”. In contrast de Certeau identifies tactics as the means whereby the weak seek to turn the tables on the strong. The language de Certeau forged has a strong aesthetic signature, that of the trickster. We see it in the way he characterizes tactical operations as based on:

clever tricks, knowing how to get away with things, ‘hunter’s cunning’, manoeuvres, polymorphic simulations, joyful discoveries poetic as well as warlike they go back to the immemorial … intelligence displayed in the tricks imitations of plants and fishes. From the depths of the ocean to the streets of the modern megalopolises, there is a continuity and permanence in these tactics.

— (ibid.: xix–xx)

This is the surprising turn in which the usual ephemerality of tactics are recognized as also possessed of a continuous and permanent presence that can never be completely displaced.

De Certeau’s ideas became steadily more influential during the 1980s, when the tactical was by definition hidden. Indeed, the opaque nature of these practices was part and parcel of the tactical aesthetic.

The ‘making’ in question is a production, a poiesis – but a hidden one, because it is scattered over areas defined and occupied by systems of ‘production’ … The increasing expansion of these systems no longer leaves ‘consumers’ any place in which they can indicate what they make or do with the products of these systems.

— (ibid.: xii)

But the artists and thinkers associated with Tactical Media in the 1990s were in the midst of a media revolution in which the arrival of the internet as a mass medium would shortly propel the once hidden activities of tactical users blinking into visibility. And with visibility would come the reflexivity that would both accelerate and transform the processes de Certeau had identified into what we called Tactical Media.

## Critiques, Legacies and Renewal

Like Situationism, Fluxus, Dada and other art-into-life movements Tactical Media is both a movement identified in a specific time and place while also exhibiting an enduring set of cultural practices. In 2009 Felix Stalder argued that the original community who saw themselves as doing Tactical Media had moved on long ago as “increasingly people were doing tactical media without thinking about tactical media. … it could no longer serve as a distinctive approach that would define a particular community.”

Others were even more damning, one of the most significant of the many critics is political theorist Jodi Dean, who described media activism as in danger of succumbing to “communicative capitalism’s perfect lure in which subjects feel themselves to be active, even as their every action reinforces the status quo” ([Dean 2002](#b-9781474207935-021-0000153): 13). More recently Nick Srnicek and Alex Williams have disparaged tactical interventions as “folk politics”, arguing that “As our political, economic, social and technological world changes, tactics and strategies that were precious and capable of transforming collective power into transformational gains have now been drained of their effectiveness” ([Srnicek and Williams 2023](#b-9781474207935-021-0000181): 10).

## Contemporary Tactics

Given the chorus of critical voices it was a surprise to many that the 2000s have witnessed some of the most effective as well as some of the most toxic expressions of Tactical Media, notably two distinct but occasionally overlapping subcultures—Anonymous and the notorious Alt-right—both of which were born and thrived on the image board 4Chan, celebrated by some as being one of the last unregulated spaces in an internet increasingly based on what has come to be known as surveillance capitalism. Little wonder that increasing controls have given rise to media hubs that have been bubbling away in the internet shadows for nearly two decades, enabling new forms of sociality and mischief to develop under the radar, that is until recently.

The most notable example of twenty first century autonomous zones are the so-called Chans or “image boards” of which 4Chan remains the most well-known. They are the meme factories, the online conspiracy nurseries and the troll farms. Unlike the tactics of previous generations these practices are almost entirely native to the internet. For better (and often for worse) it is in these domains where we find fast-moving experimental phenomena coupled with a fierce rejection of functionalist rationality that is immediately recognizable as Tactical Media.

Important conclusions flow from these developments. To begin with, the impact of the Alt-right on the 2016 US elections demonstrates how the leftist critiques of media activism’s impotence were clearly flawed. We can also conclude that the idealists who attribute intrinsically progressive values to Tactical Media were equally naïve. And finally, the most important lesson is that by dismissing or suppressing Tactical Media reactionary forces were able to step in and fill the vacuum unchallenged. Important critical thinkers such as Dean, Srnicek and Williams et al. underestimate the power of Tactical Media and overlook the importance of retaining a progressive presence in these domains.

## The Chans

The online activists Anonymous and later the so-called Alt-right emerged in large part through 4chan, an internet forum founded by Chris Poole (aka Moot) in 2003. It was originally built along the lines of “Futuba channel”, a popular Japanese site for anime fans to share images.

4chan’s importance lies in its role as a hub for radical, unfiltered free speech enabled through implementing two basic technical protocols: Contributors do not need to register. And the absence of this requirement leads to anonymity of contributors as the default setting of the platform. The designation “anonymous” in this community goes beyond the liberal norm of privacy to become a fundamentalist ideology that combines a radical commitment to free speech with a deep hostility to individual “glory hunting”.

Equally important is the protocol that facilitates ephemerality. 4chan has a commitment to tactical amnesia. Messages and images posted are quickly replaced by new postings, which, crucially, are not archived. In the words of the founder “the site has no memory”. Long before the term “surveillance capitalism” was coined 4chan’s rejection of any *data retention* can be seen as a powerful rebuke to those whose business models depend on harvesting our data. The combination of these two factors would make this platform instantly recognizable as being that entity which was supposed to have disappeared: the “autonomous zone”.

## Anonymous

4chan’s default setting of anonymity led directly to the political “brand” (or anti-brand) Anonymous, the activist group that can be seen at numerous online and offline protests sporting their distinctive Guy Fawkes masks. The online ethnographer Gabriella Coleman’s popular book *Hacker, Hoaxer, Whistleblower, Spy: The Many Faces of Anonymous* (2014) has been important in contextualizing this quasi-political movement in the wider context of message or image board culture. Coleman’s book gives a generally positive account of Anonymous and their fellow travellers. But it was published before a series of events led to 4chan to becoming associated with a radical shift to the right.

Coleman’s book, however, remains an important history and piece of cultural analysis. It provides a detailed account of a version of the trickster aesthetic, frequently dubbed “Lulz”. A derivation from the acronym LOL or Laugh Out Loud, this term represents one of the defining hacker attributes: technical curiosity laced with disruptive humour mixed with a willingness to unleash targeted mayhem. But Coleman argues that these attributes were transformed into something more progressive in 2008 when the Anonymous campaign against Scientology signalled that something of greater political importance was emerging.

However, since 2009 the FBI led other states around the world to move decisively to suppress Anonymous, arresting and prosecuting dozens of Anonymous activists and generating paralysis and paranoia as severe prison sentences were handed down. The influential writer Angela Nagle points out that this campaign of suppression led to an unintended consequence: it “created a vacuum on the image boards that the rightest side of culture was able to fill with their expert style of anti-PC shock humour and memes” ([2017](#b-9781474207935-021-0000172): 17). The suppression of Anonymous combined with the dismissal of media activism by influential critics on the left effectively neutralized the one entity with the technical skill and community kudos to have mounted a credible online challenge to the Alt-right.

## Alt-Right

Two important narratives were prompt in mapping the history and theorizing the emergence of the Alt-right: Florian Cramer’s lecture “Mapping the Alt-right” (2016) and Angela Nagle’s book *Kill All Normies* (2017). Both record and delineate from different perspectives the sequence of steps that led to neo-Nazi online enclaves, such as Stormfront, actively recruiting on 4chan and successfully propelling white supremacist narratives back into mainstream political discourse. Cramer in particular argues that what became the Alt-right played a significant role in Trump’s victory.

Nagle’s book focuses on this same trajectory but draws inspiration from a number of feminist critiques, particularly Sarah Thornton’s “The Social Logic of Subcultural Capital” (1997), which she uses to expose the uncritical tolerance and indulgence that many progressive thinkers have allowed transgressive subcultures. Nagle argues forcefully that image board culture has long harboured reactionary elements that came to full fruition in the form of the Alt-right. It fell to Andrew Breitbart, founder of the right-wing news service Breitbart, to appropriate Gramscian principles when he declared that “politics is downstream from culture”.

## Gamification

In his book *Rationality: What It Is, Why It Seems Scarce, Why It Matters* (2021) Steven Pinker asks the following question: Why, given the popularity of the Pizzagate conspiracy, did only one lone avenger, Edgar Welch, take it upon himself to set out to rescue the children? The reason he concludes is that the other followers tacitly understood that the story was a fiction but suspended disbelief and continued to engage with an entertaining story or rather an alternate reality game that “flattered their own side”. Pinker goes on to characterize this conspiracy myth as “a multi-player game that gave participants a readymade community and was too enjoyable to fact check. Myths like these”, he concludes, “are a lot more appealing than rationality”.

Pinker’s question is well put but his answer is a worrying oversimplification. He is correct in identifying the fact that Q draws on the alternate reality gaming genre, a genre where the players solve a mystery both online and in the real world. Q indeed engages a generation brought up on gaming, but Pinker’s generation is inclined to forget that gaming is not just storytelling: it includes decoding, it’s analytical. QAnon’s originality lies in going beyond declarations of “the truth”. Q will only give you clues, casting doubt on official narratives, and continually urging players to “do their own research!” “Go online” he urges “and find out yourself”.

The impact of gamification on new forms of Tactical Media was not restricted to the enclaves of the far right. The legendary investigative collective Bellingcat are part of a new generation of online independent investigators. This collective, founded in 2014, have notched up an impressive series of scoops from confirming Russian involvement in bringing down MH17, a Malaysian Airlines aircraft, through to identifying the Russian FSB operatives who attempted to assassinate Alexei Navalny.

In the remarkable book *We Are Bellingcat* the organization’s founder, Eliot Higgins, reveals how as a bored out-of-work administrator he began watching YouTube videos from the Syrian Civil War and gradually turned himself into an expert on deadly munitions based on information gleaned exclusively from what was in the public domain on the internet.

Higgins acknowledges that an important part his success is owed to the years spent immersed in intensive gaming, during which he led a group of forty players, claiming that “Social media offers a refuge to the disenchanted and frustrated and this benefited some; you could consider Bellingcat a product of this development.”

Higgins is fully aware that the capabilities he celebrates are equally likely to give rise to the destructive dimension of online communities spreading lies, provoking violence and dividing societies. From the outset he recognized that the world of online gaming was full of glaring disparities beginning with the fact that of the forty players in his online gaming group thirty-nine were male. Interestingly he also points out how the “on-line misogyny related to Gamergate and all the Trumpian toxicity that was to follow in its wake emerged at exactly at the same time as Bellingcat was founded in the Summer of 2014”.

## Conclusion

Q’s conspiracy myths sit at the extreme end of a spectrum of new methods pioneered by the populist right that bypass traditional forms of propaganda, focusing instead on establishing “grey areas” or “zones of uncertainty” in which well-established norms on subjects such as climate change, migration, poverty, race and sexual identity are not so much rebuffed through competing narratives but systematically called into question through tactics of obfuscation, irony, deniability, displacement and distraction. This is not simply about deception or the struggle between competing narratives: it is a battle for the social mind within the context of a war on knowledge itself.

Bellingcat are just one example of a relatively new cultural movement that has come to be known as Evidential Realism, a term coined by artist and curator Paolo Cirio that places them in polemical opposition to the tactics of the populist rights. This genuinely interdisciplinary movement produces interventions that foreground fact, evidence and knowledge. Typically, they combine data gathering and data analysis for broadly progressive social purposes. This movement spans a wide spectrum of generations including such artists as Lawrence Abu Hamden, Wachter & Judt, Paolo Cirio, !Mediengruppe Bitnik, Forensic Architecture, Trevor Paglen, Lev Manovich, Morehshin Allahyar, to name but a few, and could be described as a twenty first century version of nineteenth-century naturalism, a movement that was itself also based on an idealized epistemology founded on a cultural representation of the scientific empiricism of the time. It is noteworthy that the Evidential Realists are perhaps the first fully-fledged *research-led* art movement whose art is founded on quantitative data.

This movement is an important development transforming the debates around the relationship between art and research as well as knowledge and democracy. It is, however, arguable just how “tactical” the Evidential Realists are. Forensic Architecture, to take one example, is a group with a well-resourced institutional affiliation to Goldsmiths at the University of London with a membership made up of journalists, architects, artists, 3D modellers, animators, coders, lawyers. Of course, there is nothing wrong with institutional heft—we could see it as an example of media activism maturing. But given its contrasting position in relationship to genuine grass-roots movements originating on the far right there might be a problem.

The problem lies in the fact that the Evidential methods have resulted in a visual rhetoric that creates an aura of scientific authority and perhaps incontrovertibility. It thus overlooks the core of the epistemic trouble we are in. The growing resentment against experts is not entirely irrational. It is based on the fact that their power is often located outside of the public domain and beyond public scrutiny, or engagement. The sociologist Noortje Marres has argued that in the context of “today’s dynamic and diverse public spheres epistemic authority will have to be earned the hard way through an exchange between epistemically diverse viewpoints” ([2018](#b-9781474207935-021-0000167): 441).

To be as politically transformative as the Alt-right the Evidential Realist movement will need to learn the lessons that Tactical Media still has to teach about the changing nature of public participation and public engagement.

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The emergence of digital technology is transforming our culture in ways that are hard to grasp. New media art and Deconstruction can both be considered as responses to the challenges of computerization and digital technology. The writings of Jacques Derrida, Bernard Stiegler and others connected with Deconstruction offer the most profound engagement with questions of technicity that are particularly pertinent to our current technologized condition, as does art involving new forms of media, networks and technologies. “Deconstruction” in this context refers to the philosophical practice of the close reading of texts to reveal their internal structures and contradictions, exemplified in much of Derrida’s work. “Technicity” is the term for how there is nothing about the human that is not always already technical

## Technicity and Deconstruction

Derrida and Stiegler both owe their understanding of human technicity to the work of the palaeo-anthropologist André Leroi-Gourhan. He suggests that the achievement of upright posture frees the hands for tool use, which in turn eventually frees the lower jaw for language. The upright posture also enables the spinal column to support a heavier braincase, enabling the expansion of the cortical fan in the cerebellum, the cortex being the area of the brain that controls speech. Leroi-Gourhan proposes that tool use, far from being the result of expanded intelligence, is a zoological and evolutionary phenomenon, much like the acquisition of a claw exuded from the body. This leads to the apparently paradoxical situation in which the human brain is empty at birth and is thus capable of thinking everything, unlike insect societies, in which “each individual must possess the entire capital of collective knowledge, and the society can evolve only at the rate of the palaeontological drift” ([Leroi-Gourhan 1993](#b-9781474207935-022-0000135): 228). The externalization of human memory is a process that, for Leroi-Gourhan, starts with the earliest flint tools and continues right up to “punched cards and electronic memory” (ibid.: 264).

Derrida cites Leroi-Gourhan in his groundbreaking book *Of Grammatology*. For Derrida Leroi-Gourhan offers another understanding of what it means to be human, one that sees it “as a stage or an articulation in the history of life—of what I have called differance—as the history of the gramme” ([Derrida 1976](#b-9781474207935-022-0000092): 84). From this Derrida suggests that we eschew our reliance on “the concepts that habitually serve to distinguish man from other living beings (instinct and intelligence, absence or presence of speech, of society, of economy, etc. etc.)” and instead think about the idea of the program, especially as understood in cybernetics, and in relation to the idea of “the trace as the unity of a double movement of protention and retention”, which goes “far beyond the possibilities of the ‘intentional consciousness’” (ibid.). Thus

one could speak of a ‘liberation of memory,’ of an exteriorization always already begun but always larger than the trace which, beginning from the elementary programs of so-called ‘instinctive’ behavior up to the constitution of electronic card indexes and reading machines, enlarges differance and the possibility of putting in reserve: it at once and in the same movement constitutes and effaces so-called conscious subjectivity, its logos, and its theological attributes. The history of writing is erected on the base of the history of the gramme as an adventure of relationships between the face and the hand.

— (ibid.)

In Derrida’s words Leroi-Gourhan describes the slow transformation of manual motor functionality in terms of grasping and manipulation, which frees the audiophonic system for speech, and the hand for writing. For Stiegler, Leroi-Gourhan showed that “it is impossible to disassociate anthropogenesis from technogenesis” which “pursues the conquest of mobility, that is, of life, by means other than life” and “that accordingly, the difference between human- and animal-kind is to be rethought” and “that the technical exteriorization of the living marks the origin of humanity”, and “the technical object constitutes as such a memory support” ([Cohen 2001](#b-9781474207935-022-0000083): 248). Finally, this means that language and instrumentality “are two aspects of the same phenomenon”. Stiegler points out that Derrida picked up on Leroi-Gourhan’s analysis of computers and other electronic audio-visual technologies as the latest stage in the history of the exteriorization of memory, which anticipated “hypertext, email and the World Wide Web” (ibid.: 249). This history is that of the “technical conquest of mobility, amounting to an ever-growing power in formalization, abstraction and deterritorialization”. Leroi-Gourhan’s ideas have been taken up and both extended and radicalized by Stiegler himself. At the beginning of the first volume of his magnum opus, *Technics and Time*, Stiegler asks “‘who’ or ‘what’ does the inventing?” and “‘who’ or ‘what’ is invented?” What he means by this is that it is difficult to determine what came first, humans or tools ([Stiegler 1998](#b-9781474207935-022-0000156): 134).

In his book *Archive Fever*, which is concerned with the Freudian legacy, Derrida suggests that the archive is a form of exteriorized supplement for our spontaneous, living, psychic memory. As such, “the archive takes place at the place of originary and structural breakdown” of “spontaneous, alive and internal experience” ([Derrida 1996](#b-9781474207935-022-0000106): 11). As such, the existence of the archive is also threatened by the death drive. There is “no archive without consignation in an external place, which assures the possibility of memorization, of repetition, of reproduction, or of reimpression”, and repetition compulsion is “indissociable from the death drive … [A]nd thus from destruction”, which means that all that permits and conditions archivization also exposes it to, and even menaces it with, destruction, “introducing, *a priori*, forgetfulness … into the heart of the monument” (ibid.: 11–12).

In *Archive Fever*, Derrida speculates to what degree psychoanalysis has been “determined by a state of the technology of communication and archivization” and how it would have been determined had Freud and his contemporaries “had had access to MCI and AT&T telephonic credit cards, portable tape recorders, computers, printers, faxes, televisions, teleconferences and above all E-mail” (ibid.: 16). Appropriately for someone who published a book entitled *La carte postale*, email is a privileged instance in these technical transformations, particularly in relation to the speed of its transmission. Derrida suggests that email “is on the way to transforming the entire public and private space of humanity, and first of all the limit between the private, the secret (private or public), and the public or the phenomenal” ([Derrida 1996](#b-9781474207935-022-0000106): 17). He continues that “it is not only a technique, in the ordinary and limited sense of the term: at an unprecedented rhythm, in quasi-instantaneous fashion, this instrumental possibility of production, of printing, of conservation, and of destruction of the archive must inevitably be accompanied by juridical and thus political transformations” (ibid.).

## Telecommunications

In 1980 Derrida published his book *La carte postale*, the first part of which, “Envois”, was in the form of a series of texts ostensibly on the back of picture postcards, sent by someone, maybe Derrida, to an unnamed correspondent, who seems at least to be a lover. In the book Derrida admits to his fascination with the postal system and his desire

to write and first to reassemble an enormous library on the courier, the postal institutions, the techniques and mores of telecommunication, the networks and epochs of telecommunication throughout history – but the ‘library and the history’ themselves are precisely but ‘posts’, sites of passage or of relay among others, stases, moments or effects of ‘restance’, and also particular representations, narrower and narrower, shorter and shorter sequences, proportionally, of the Great Telematic Network, the ‘worldwide connection’. What would our correspondence be, and its secret, the indecipherable, in this terrifying archive.

— ([Derrida 1987](#b-9781474207935-022-0000103): 27)

However, he suggests that

an entire epoch of so-called literature, if not all of it, cannot survive a certain technological regime of telecommunications (in this respect the political regime is secondary). Neither can philosophy, or psychoanalysis. Or love letters. … Refound here the American student with whom we had coffee last Saturday, the one who was looking for a thesis subject (comparative literature), I suggested to her something on the telephone in the literature of the 20th century (and beyond), starting with, for example, the telephone lady in Proust or the figure of the American operator, and then asking the question of the effects of the most advanced telematics [*la télématique la plus avancée*] on whatever would still remain of literature. I spoke to her about microprocessors and computer terminals, she seemed somewhat disgusted [*avait l’air un peu dégoutée*]. She told me that she still loved literature (me too, I answered her, *mais si, mais si*). Curious to know what she understood by this.

— (ibid.: 204)

J. Hillis Miller suggests that “one of Derrida’s main points in *The Post Card* is that it is a feature of the new regime of telecommunications to break down the inside/outside dichotomies that presided over the old print culture” ([Hillis Miller 2000](#b-9781474207935-022-0000118)). He goes on to propose that the “postcard stands as a proleptic anticipation of the publicity and openness of the new communications regimes” (ibid.). This new regime involves “the breakdown of traditional boundaries between inside and outside brought about by new communication technologies” in which “the new electronic space, the space of television, cinema, telephone, videos, fax, email, hypertext, and the Internet, has profoundly altered the economies of the self, the home, the workplace, the university, and the nation-state’s politics” (ibid.). Hillis Miller claims that these “were traditionally ordered around the firm boundaries of an inside-outside dichotomy, whether those boundaries were the walls between the home’s privacy and all the world outside or the borders between the nation-state and its neighbours. The new technologies invade the home and the nation. They confound all these inside/outside divisions” (ibid.).

In the same year as the publication of *La carte postale*, 1980, Sherrie Rabinowitz and Kit Galloway linked two large live projections of streets in New York and Los Angeles in their “public communication sculpture” *Hole-in-Space*. “Art” in the sense that term has been understood and used in the West since the Renaissance is a specific artefact of modernity. It is concomitant with the emergence of modern conceptions of privacy, individuality and subjectivity. As such it is part of a number of related phenomena, including the printed book, the proscenium arch in theatre, the art gallery and museum, the distinction between the domestic and the public spheres, and the rise of mass literacy and letter writing, and even the nation-state. Together these phenomena can be thought of as different aspects of the framework of modernity, the structure that articulates the binaries, inclusions and exclusions through which it manages its operations.

With the development of forms of globalized communication and mass media, starting in the nineteenth century, this framework has been increasingly challenged. This can be seen from the invention of the telephone, and the postcard, in the 1870s, through to the internet and the World Wide Web. Artists from Duchamp in the early part of the twentieth century to mail art in the 1960s have investigated the possibilities of such technologies as means of critiquing art. In the last thirty years new technologies have increasingly brought the older framework into question, and artists have also responded, from work involving satellites and Slow-Scan television in the 1970s and 1980s through to net.art and beyond.

## The Epoch of the Postal System

Once the post can be used for correspondence between individuals it necessitates the idea of confidentiality and privacy and by extension intimate confession and secrecy. This sense of privacy is a precondition for the emergence not just of the modern subject but also of modern aesthetics, in that it necessitates the development of an articulation of the conditions of judgement, which in turn requires an understanding of the relation between the private and public. However, the relation between privacy and the post was brought into doubt with the development of modern mass and telecommunications media, prefigured by the postcard, which symbolized the transformations in the relations between the private and the public brought about by such new technologies. Since that point artists increasingly engaged in the possibilities of new forms of media and communication, including postcards, telegraphs and, since the end of the Second World War, computers and digital networks.

Up to the beginning of the seventeenth century the postal service was the preserve of the ruling powers and intended to be a system of control rather than reciprocal communication. This only changed in 1600, when Cardinal Duke Albrecht VII granted the Thurn und Taxis family formal permission to charge postage for private letters (thus legitimizing already existing, albeit illegal practice). For media theorist Bernhard Siegert this moment represents the beginnings of what he calls the “epoch of the postal system” ([Siegert 1999](#b-9781474207935-022-0000153): 8). Access to the postal system produced the modern “subject” by granting users position and status within the system, with a concomitant sense that they could control their own affairs, while at the same time coming increasingly under the control of the state.

The sense of privacy mentioned above is a precondition for the emergence not just of the modern subject but also of modern aesthetics, in that it necessitates the development of an articulation of the conditions of judgement, which in turn requires an understanding of the relation between the private and public. In his epistolary response to King Friedrich Wilhelm of Prussia’s query, “What is enlightenment?”, Immanuel Kant proposed that greater freedom of the use of reason in the public sphere should be granted in exchange for stringent restrictions of its use in private. Public in this case meant “the use which a person makes of [reason] as a scholar before the reading public”, private “that which one may make of it in a particular civil post or office which is entrusted to him”, as in the case of a taxpayer, clergyman or soldier ([Kant 1999](#b-9781474207935-022-0000121): 18. According to the *Critique of Pure Reason* public reason, the public consensus arrived at by those engaged in rational-critical debate with one another, is the means by which it is decided whether something is true or not. “The touchstone whereby we decide whether our holding a thing to be true is conviction or mere persuasion is therefore external, namely the possibility of communicating it and of finding it be valid for all human reason” (quoted in [Habermas 1991](#b-9781474207935-022-0000112): 108).

## Public Sphere

In his *Critique of Judgement*, which deals with judgement and aesthetics, Kant declares the beautiful to be that which can be universally communicated and agreed upon. As he puts it.

The empirical interest in the beautiful exists only in society. And if we admit that the impulse to society is natural to mankind, and that the suitability for and the propensity towards it, i.e., sociability, is a property essential to the requirements of man as a creature intended for society, and one, therefore, that belongs to humanity, it is inevitable that we should also look upon taste in the light of a faculty for estimating whatever enables us to communicate even our feeling to every one else, and hence as a means of promoting that upon which the natural inclination of every one is set.

— ([Kant and Meredith 1952](#b-9781474207935-022-0000124))

Among the claims Kant makes about judgement in the Third Critique is that it is necessary to be able to judge what is beautiful without recourse to concepts, via a subjective but universal common sense, *sensus communis*, which is in fact the precondition of all cognition (ibid.). As Jürgen Habermas has pointed out, Kant was writing when the “public sphere”, the mediation zone between the state and the private sphere, created by the liberal bourgeoisie, was most powerful ([Habermas 1991](#b-9781474207935-022-0000112): 89–140).

In 1865 Heinrich Stephan proposed the idea of a “post page” or what we would now call the postcard at the fifth conference of the German-Austrian Postal Union in Karlsruhe ([Siegert 1999](#b-9781474207935-022-0000153): 147). This proposal was rejected by his superior, General Post Director Philipsborn, on the grounds of indecency (ibid.: 148). In that, by removing the envelope, it made public what had previously been private and, indeed, had been the very foundation of modern conceptions of privacy and the private self.

The “correspondence card” was, however, introduced in Austria in 1869 (ibid.: 150). A year later Stephan was able to introduce the card in Germany, and to distribute his “field-post correspondence cards” to troops fighting in the Franco-Prussian War, a move copied by the French (ibid.: 152–3). Soon postcards bearing images started to appear and by 1879 the royal Bavarian court photographer Alphons Adolph had developed a means to reproduce photographs in print on cards, thus making possible the photographic picture postcard (ibid.: 161). By 1900 so-called “real photo” postcards had been developed that included photographs printed on film stock paper and, in 1906, inspired by such cards Kodak Eastman produced a pocket folding camera that could be used to take photographs for attaching to cards. Though there is no direct causal link it is not a coincidence that the period that saw the emergence of the postcard also saw the radical transformation of art, starting with the revolutions in the representation of perception undertaken by the Impressionists, followed by successive waves of the avant-garde. Following Jonathan Crary and Richard Rorty this might be characterized as the end of art “as the mirror of nature”, a private interior reflection of an exterior reality ([Crary 1990](#b-9781474207935-022-0000086); [Rorty 1980](#b-9781474207935-022-0000147)). Crary famously ascribes the development of these new forms of art to transformations in the understanding of perception preceding but also embodied in photography. It can be suggested that they are also bound up with transformations in the relations between the private and the public brought about by new means of telecommunication such as the postcard.

## Art and Telecommunications

During the First World War the first artworks actually to use telecommunications networks appeared. Some of the Futurists serving in the army sent back letters praising war, intended as artworks. In 1916 Duchamp also sent four postcards to his then neighbour, containing syntactically plausible but meaningless writing. These may be the first example of what would be known later as “mail art”. Shortly after the war the Hungarian artist and designer László Moholy-Nagy reputedly produced the first work of art to exploit the telephone system in its production. According to his own account:

In 1922 I ordered by telephone from a sign factory five paintings in porcelain enamel. I had the factory’s color chart before me and I sketched my paintings on graph paper. At the other end of the telephone, the factory supervisor had the same kind of paper, divided into squares. He took down the dictated shapes in the correct position. It was like playing chess by correspondence.

— ([Moholy-Nagy 1947](#b-9781474207935-022-0000141): 79)

With the exception of the above, it was not until after the Second World War that artists really began to exploit the meaning and possibilities of new technologies and means of telecommunication. The Second World War was the catalyst for accelerated technological development on a number of fronts. It led directly to the development of atomic weaponry, radar, massive advances in telecommunications, and the first electronic digital binary computers, as well as scientific and technical discourses such as cybernetics, information theory and systems theory. It is therefore not surprising that, after the war, the possibilities of telecommunications networks began to be exploited by artists. In the 1950s and early 1960s in the United States John Cage developed work that engaged with notions of interaction, multimedia and with the possibilities of electronics, such as his famous “silent piece”, *4’ 33”*. His work was one of the main inspirations not just for other composers working with electronic means but also for artists interested in process, interaction and performance, such as Allan Kaprow and those involved with the Fluxus group.

Owing to the international nature of the movement, those involved in Fluxus used the postal system a great deal to exchange material and ideas. The movement itself was deliberately international, involving members from the United States, Europe and Japan, and eschewed any identification with particular nations. It also demonstrated a fascination with telecommunications, through various works that referred to postal and other communications systems. This became a process of making art in its own right. The Fluxus poet Robert Filliou invented the term “Eternal Network” to refer to the long-term inseparableness of art and life. This became synonymous with Fluxus’s use of the post as a vehicle for art. Filliou, along with other Fluxus artists such as Ben Vautier, Ken Friedman, Robert Watts, Nam June Paik and Dick Higgins, used postcards and other correspondence material thus from the late 1950s onwards. This kind of work was paralleled by similar projects undertaken by the artistic group the Nouveau Réalistes in France, which had many affinities with Fluxus, and, indeed shared some members. Among those involved with Nouveau Realisme were Yves Klein, Daniel Spoerri, Piero Manzoni, Niki de Saint Phalle, Christo, Arman and Jean Tinguely. Klein actually sent letters and cards franked with a plain (Klein) blue stamp.

This clearly had important effects in the arts. The traditional spaces in which the arts took place, and by which they were kept separate, began to be breached by the outside. In her famous article “Sculpture in the Expanded Field”, first published in 1979, Rosalind Krauss suggested that in the 1960s and 1970s sculpture had departed the gallery to become both architectural and part of the environment (1979). Krauss’s title phrase could be easily adapted to describe similar transformations in painting, photography, film, music, etc. This in turn rendered attempts to formalize the rules of different arts problematic. Much as peace between the nation-states was predicated on each nation having their own sovereignty in terms of law and politics, the arts maintained their own formal laws by also maintaining their autonomy and separation from each other. Formalism permitted the legislation of the formal laws that enable the essences and limits of the arts. In a sense it operated like a kind of border police patrolling those limits, and making sure they were not breached. It is not coincidental that the modern system of the arts, and the beginnings of Formalism, emerge at the same time as that of the modern system of nation-states. Nor is it coincidental that the modern system of the arts as separate, autonomous domains is collapsing at the same time as the end of the nation-state.

## Telematics

In the late 1950s and 1960s theorists such as Marshall McLuhan and R(ichard) Buckminster Fuller began to examine the social transformations wrought by new technologies of information and communication. The expanded possibilities of computing began to be explored in projects such as the first elements of the internet (or ARPANET, as it was first known, after its funder, the Advanced Research Projects Agency or ARPA); Douglas Engelbart’s Knowledge Augmentation Project, also funded by ARPA, which led to the first user interface and the computer mouse; and Ted Nelson’s concept of the computer as a medium for non-linear, associative texts, or “hypertext”. At the same time artists started to experiment with the artistic possibilities of new technologies such as computers. In the early 1960s artists such as Nicolas Schöffer in France and Roy Ascott in Britain began to be interested in technoscientific ideas such as cybernetics. In the mid-1960s the first computer art shows were mounted, in Germany and the United States. These were followed by exhibitions and events such as Nine Evenings at the Armory in New York, staged by Billy Klüver and Robert Rauschenberg’s group Experiments in Art and Technology (E.A.T.) in 1966. E.A.T. was founded to foster collaborations between artists and engineers.

In the years that followed, a number of major exhibitions involving new technologies were held, including “The Machine as Seen at the End of the Mechanical Age” at MOMA in 1968, which accompanied a show of work commissioned by E.A.T., “Some More Beginnings”, at the Brooklyn Museum. In the same year the legendary exhibition “Cybernetic Serendipity”, curated by Jasia Reichardt, was held at the ICA in London. A year later “Event One” took place in London (the latter organized by the Computer Arts Society, the British equivalent of E.A.T.). In 1970 critic and theorist Jack Burnham organized “Software—Information Technology: Its Meaning for Art” at the Jewish Museum in New York. Like “Cybernetic Serendipity” this show mixed the work of scientists, computer theorists and artists with little regard for any disciplinary demarcations. Also in 1970 Kynaston McShine curated “Information” at MOMA, which dealt with the issues and possibilities of new technologies, but only featured the work of artists. In 1971 the results of Maurice Tuchman’s five-year “Art and Technology” programme were shown at the Los Angeles County Museum. Perhaps the most important proposed show in terms of network art at this time was “Art by Telephone”, which was to have been held at the Museum of Contemporary Art in Chicago in 1969, if it had not been abandoned for technical reasons. Following Moholy-Nagy’s alleged strategy for producing the “EM paintings”, artists would participate by giving instructions for the construction or installation of their artworks by phone and by no other means. This was also the period in which Derrida was publishing his early major works.

In the late 1960s the Advanced Research Projects Agency (ARPA) of the American Defense Department had started to explore the possibilities of networked computing. The result was the formation of the ARPANET, the ancestor of the internet, initiated in 1969 as a network of four computers, three in California and one in Utah, which were linked by telephone lines. Some artists continued to investigate the possibilities of new technologies, including Douglas Davis, Roy Ascott, his ex-student and colleague Stephen Willats, and the Australian performance artist Stelarc. Davis’s work is of particular interest in relation to network art, consisting as it does of performances and events involving technologies such as satellite communications and Slow-Scan television. Davis started work in this vein in 1970. Davis was one of a number of artists who engaged with the possibilities of television as a medium. The earliest example of such work is probably the inclusion of televisions in installations by Fluxus artists Wolf Vostell and Nam June Paik in the mid-1960s. Paik would later be one of the first artists to exploit the early portable video equipment produced by Sony in the late 1960s to create artwork, and thus one of the first video artists. In 1969 the Howard Wise Gallery in New York put on a show entitled “TV as a Creative Medium”. In the early 1970s collectives such as Raindance Corporation, founded by artists Frank Gillette and Paul Ryan and journalist Michael Shamberg, and publications such as *Guerrilla Television* and *Radical Software*, put forward radical agendas for liberating and democratizing television. In the late 1970s Sherrie Rabinowitz and Kit Galloway were funded by NASA to put together the *Satellite Arts Project* (1977), a project in which satellite technology and television were used to bring remote participants together to dance. Later their Electronic Café (1984) brought together artists in various areas of Los Angeles in a “telecollaboration”.

At the same time, many of the ways that artists in the 1960s had been using and thinking about such technologies began to be realized practically. The economic crises of the 1970s led to a restructuring of capitalism and global finance, which was aided by the increasing ubiquity of networked computing. This in turn heralded the beginnings of what became known as the post-industrial economy, in which information became the dominant mode of production (in the developed countries at least), as predicted by pundits such as Alvin Toffler and Daniel Bell. The rise of the “post-industrial” society was responded to in the cultural sphere by the emergence of “postmodernism”, partly as a critical response to the ubiquity and power of information technologies and communications networks. In France, at the end of the 1970s, two academics, Simon Nora and Alain Minc, wrote a report for President Giscard d’Estaing which declared the “computerisation of society” and the advent of “telematics”, meaning the coming together of computers and telecommunications ([Nora and Minc 1980](#b-9781474207935-022-0000144)). Among other things, this led to the installation of Minitel, the networked public computer information system. According to Jean-François Lyotard, in his report for the Government of Quebec on the state of knowledge in the Western world, published in English as *The Postmodern Condition*, which was also, in part, a response to Minc and Nora’s own report, the postmodern was a result of transformation of knowledge into information necessitated by the “proliferation of information-processing machines” and their effect on the “circulation of learning” ([Lyotard, Bennington and Massumi 1984](#b-9781474207935-022-0000138)).

In the late 1970s the possibilities offered by “telematics” inspired a number of artists to put together projects involving computers and telecommunications networks. In 1979 Bill Bartlett organized Interplay, a computer communications project, involving near-instantaneous response, for the Computer Culture conference in Toronto in 1979. This led to the founding in 1980 of ARTBOX, an electronic mailbox program for artists to organize communications projects. In 1982 ARTBOX was renamed ARTEX, under which name it hosted a number of important telematic projects. Among the most well-known of these was Roy Ascott’s *La Plissure du Texte*, proposed for “ELECTRA 1983”, Frank Popper’s survey of the use of electricity in art, held at the Musée d’Art Moderne de la Ville de Paris in 1983. For *La Plissure du Texte*, which was online for twelve days, twenty-four hours a day, Ascott invited artists and groups from eleven cities to help create an evolving, participatory fairy tale.

Another important venue for such work was the short-lived series of Wiencouver festivals, which took place in the imaginary city of Wiencouver which hung “invisible in the space between its two poles”, Vienna (Wien) and Vancouver, according to one of its founders, Hank Bull (Grundmann 1984). Wiencouver in 1979 was conceived and initiated when Bull flew from Vancouver to Vienna to attend “Audio Scene 79”, and set up networks of correspondence between the two cities. The next year Wiencouver II involved a mail art exchange exhibition, in which contributions were shown simultaneously in venues in each city. A special global artists’ telecom conference was also organized by Bill Bartlett, which involved communicating with a dozen other cities through Slow-Scan video, and collaging an enormous text by computer.

## Nuclear Criticism

In 1984 Derrida made his contribution to the then emerging area of “nuclear criticism”. His paper “No Apocalypse, Not Now (Full Speed Ahead, Seven Missiles, Seven Missives)”, given at the conference “Nuclear Criticism”, proclaimed among other things that nuclear war threatened the “remainderless destruction of the archive”, or in other words the totality of the material traces of human knowledge and cultural production. For Derrida literature is particularly threatened by this, as it refers only to itself, unlike, for example, science. Thus for Derrida firstly literature is always already bound up with the possibility of total destruction and therefore with the threat of nuclear war, even before it was technically possible. According to Derrida it is writers such as Kafka, Joyce and Mallarmé who engage with this best, rather than those dealing directly with such war ([Derrida 1984](#b-9781474207935-022-0000098): 27–8).

Derrida talks of the “extraordinary sophistication of [nuclear war’s] technologies—which are also the technologies of delivery, sending, dispatching, of the missile in general, of mission, missive, emission and transmission, like all technè” (ibid.: 24). Peter Schwenger wittily glosses this idea by pointing out that, according to the principle of deterrence, “all missiles (missives) are marked ‘return to sender’” ([1992](#b-9781474207935-022-0000150): 10–11). According to Derrida, the economy of speed of the nuclear epoch involves “the crossing of certain thresholds of acceleration within the general machinery of a culture, with all its techniques for handling, recording and storing information” ([1984](#b-9781474207935-022-0000098): 20). Principal among such techniques is “real-time computing”, which was developed as a direct response to the threat of nuclear destruction during the Cold War, with projects such as the SAGE continental air defence system, the ARPANET, as well with research into computer graphics, interfaces, artificial intelligence and cybernetics. They embodied a situation in which the technical achievement of ever-greater speed has become a matter of survival, particularly with the development of intercontinental ballistic missiles, which combined the range and speed made possible by jet propulsion with the destructiveness of nuclear weaponry. The development of complex real-time systems such as SAGE was a reaction to the capacity to wage war and wreak destruction at distance and at great speed.

These Cold War technologies began to find civilian applications in relation to the economic and social crises of the late 1960s and early 1970s. The deregulation of finance following the collapse of the Bretton Woods Agreement in the early 1970s was accompanied by the increasing application of real-time computer technology to financial trading. This in turn greatly enabled the globalization of finance. The expansion that has accompanied this globalization is on a scale that now dwarfs the financial activities of most nation-states. It also, as events at the end of the 1990s have shown, brings with it considerable dangers, with markets handling trillions of dollars a day, and able, even obliged, because of developments in communications technologies, to make immediate responses to world events. The technologies in question developed out of the military needs for unprecedented levels of attention and communication. The global market now operates with the same hair-trigger responsiveness as those on nuclear alert, and using the same kind of equipment. The trader on the stock market floor is using real-time computing technology directly descended from SAGE, the ARPANET and other interactive technologies developed for nuclear defence. Thus the nuclear economy of speed becomes the speed of the economy.

The threat of nuclear war may have receded, for the moment at least, but the implications of the digital technologies which helped develop atomic and nuclear weaponry have not. Einstein famously described the computer as the “information bomb”, the second of three bombs, following the atomic bomb, and preceding the demographic bomb, and the one which would have the most incalculable consequences for humanity in the post-war era. As we archive more and more of our cultural production in digital form, we are threatened by the remainderless destruction of the archive without the necessity of nuclear war (though the electromagnetic pulse of a nuclear explosion would knock out electronic networks, possibly permanently). The complex system of digital networks is increasingly vulnerable to breakdown, and the concomitant loss of the archive. The digital cloud thus becomes a kind of atomic cloud, an image of potential destruction. This brings us in confrontation with the finitude, vulnerability and fragility of the archive, digital or otherwise.

## The Web

Perhaps the most important event in terms of digital art practice at this time was the development of the first user-friendly web browser in 1994. The World Wide Web had been developed as a result of the pioneering ideas of Tim Berners-Lee, a British scientist at the European Nuclear Research Centre (CERN) in Switzerland. Berners-Lee was interested in using the internet to allow access to digital documents. To this end he developed a version of the Standard Generalized Markup Language (SGML) used in publishing, which he called Hypertext Markup Language or HTML. This would allow users to make texts and, later on, pictures, available to viewers with appropriate software, and to embed links from one document to another. The emergence of the web coincided almost exactly with the collapse of the Soviet Union and it was the new-found sense of freedom and the possibilities of cross-border exchange, as well as funding from the European Union and NGOs such as the Soros Foundation that helped foster the beginnings of net art in Eastern Europe, where much of the early work was done. When “user-friendly” browsers such as Mosaic and Netscape came out in the early to mid-1990s the possibilities of the web as a medium were seized upon by a number of artists, who, in the mid-1990s, started producing work under the banner of “net.art”. This meant work that was at least partly made on and for the web and could only be viewed online. The term “net.art” was supposedly coined by Vuk Ćosić in the early 1990s to refer to artistic practices involving the World Wide Web, after he had received an email composed of ASCII gibberish, in which the only readable element was the words “net” and “art” separated by a full stop. Since then there has been an extraordinary efflorescence of work done under the banners of network art, net.art or net art, from Vuk Ćosić, Olia Lialina, Alexei Shulgin, Rachel Baker, Heath Bunting, Paul Sermon, 0100101110101101.org, Natalie Bookchin, Lisa Jevbratt, Radioqualia, ®Tark, Matt Fuller to Thomson & Craighead, and many others. At the same time, discussions and commentary about technology and art have proliferated through email lists such as Rhizome, nettime and CRUMB (Beryl Graham and Sarah Cook’s digital curation list based at Sunderland University), as well as publications such as *Mute*. In their work [[*www.jodi.org*](www.jodi.org)](www.jodi.org), Joan Heemskerk and Dirk Paesmans, known collectively as JODI, present what appears to be meaningless chaos on the screen. However, the source HTML turns out to be in the form of a diagram of how to build a nuclear bomb.

## Conclusion

Artists using new technologies exemplify the complexity of the idea of hospitality. In general digital networks such as the web are about exchange, whether that of money for goods, social links and relational exchanges in social networks, or the exchange of speech and dialogue in online forums. The work of these artists refuses this demand for exchange and profit within a restricted economy. Thus they are in a sense parasitical on the web. The word “parasite” comes from the Greek “*para sitos*”, meaning “beside the grain”, and refers to those animals that take advantage of grain stores to feed. They are the creatures to whom hospitality must be offered, as a gift, without expectation of return, which means that while they are bound up with the technological systems that comprise the web, they are not part of the restricted economy of exchange, profit and return that is at the heart of capitalism, and to which everything else ends up being subordinated and subsumed. Thus they find an enclave away from total subsumption not outside of the market, but at its technical core.

In the technological regime of the book, artworks were supposedly clearly delimited with the painting in its frame, the book in its cover, the symphony or play in its time and place. But by the later twentieth century this has been massively complicated by new technologies and ways of thinking. The book, self-enclosed, autonomous and linear, is being increasingly challenged by “Hypertext”, non-linear textuality enabled by the computer, but already anticipated by, among others, Derrida, in his book *Glas*, in which multiple columns of heterogeneous texts are juxtaposed, thus breaching the supposed totality of the book form ([Derrida 1974](#b-9781474207935-022-0000089)). This was one of Derrida’s major strategies, to question the limits of the work of art, and the boundaries between the inside and outside. This is exemplified in his discussion of a gnomic phrase found among Nietzsche’s papers—“I have forgotten my umbrella”—which is liable to be interpreted as extraneous to, outside of Nietzsche’s philosophical corpus. Derrida, however, not only questions how legitimate such a judgement is, but also suggests that the phrase itself undoes any notion of totalizing coherence in Nietzsche’s work ([Derrida Harlow 1979](#b-9781474207935-022-0000109): 125–33).

Derrida continues this line of thought in his engagement with Kant in his essay “Parergon”, in which he deconstructs the relation of the frame and other supposedly extraneous elements to the work of art itself ([Derrida 1987](#b-9781474207935-022-0000103)). Rosalind Krauss invokes this in her book *A Voyage on the North Sea: Art in the Age of the Post-Medium Condition*, as a way of thinking about art after the age of formalist medium specificity:

From the theory of grammatology to that of the parergon Jacques Derrida built demonstration after demonstration to show that the idea of an interior set apart from, or uncontaminated by, an exterior, was a chimera, a metaphysical fiction. Whether it be the interior of the work of art as opposed to its context, or the interiority of a lived moment in experience as opposed to its repetition in memory or via written signs, what deconstruction was engaged in dismantling was the idea of the proper, both in the sense of the self-identical—as in “vision is what’s proper to the visual arts”—and in the sense of the clean and pure—as in “abstraction purifies painting of all those things, like narrative or sculptural space, that are not proper to it”. That nothing could be constituted as pure interiority or self-identity, that this purity was always already invaded by an outside, was the argument mounted to scuttle the supposed autonomy of the aesthetic experience, or the possible purity of an artistic medium, or the presumed separateness of a given intellectual discipline. The self-identical was revealed as, and thus dissolved into, the self-different. ([Krauss and Broodthaers 2000](#b-9781474207935-022-0000132): 32)

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# Section III: Theorists

In 1964 Marshall McLuhan’s book *Understanding Media* popularized his dictum “the medium is the message”. The Canadian literature scholar’s explorations of media had greatest impact in academe and popular culture in the early years of the electronic or “information” age in the 1960s and 1970s. McLuhan oriented his background in literature and new criticism towards the social and psychological effects of emerging mass media in early studies of advertising, newspapers and comics (*The Mechanical Bride*, 1951) and the printed book (*The Gutenberg Galaxy*, 1962), but he turned more to the effects of television, computers, satellite communications as they became the dominant media technologies towards the 1970s. In 1966 *LIFE* magazine, following a festival of contemporary art devoted to McLuhan’s work, noted how artists had begun to recognize the importance of his speculative explorations on media, the senses and the new electronic environment and dubbed him “Oracle of the Electronic Age” ([Howard 1966](#b-9781474207935-023-0000082): 92).McLuhan’s explorations of media treated them as “extensions” of the human senses, extending thought, body and senses through speech, writing, printing and mechanical reproduction and electronic communications. His examples spanned historically from the medieval oral and acoustic environment of a teacher discussing manuscripts with students; through the invention of the printed book, its isolation of the silent reader and mass-produced extensions of linear, standardized and vernacular language defining nation identities; to the global satellite-based instantaneity of communications in the electronic age. While refusing the label of historian, he recognized the role of mass media in reshaping the environment across time and space, historically and geographically ([McLuhan 1975](#b-9781474207935-023-0000135): 75). Thus, while maintaining his interest in the ways that the spoken word, literature and writing organized and gave meaning to social relations, his work encompassed the rise and significance of telegraphy, telephony, radio, television, satellite communications and computing. He addressed the role of media technology in shaping art, literature, music and design across historical periods, beginning with the invention of the printing press, nineteenth-century industrialization, early twentieth-century electrification and mid twentieth-century electronic revolution.

This depiction of McLuhan as visionary of the electronic age of networked and social media and convergent media only emerged after his death in 1980. On its masthead *Wired* magazine called him the “patron saint” of new media (*Wired* magazine, March 1993). However, it is perhaps more accurate to say that he less predicted the future of new media—and the arts of new media—than prefigured them in his voluminous, sometimes elliptical and paratactic output. McLuhan rejected the portrait of himself as a philosopher, theorist or scientist of media, because he was more concerned with the unconscious and counter-intuitive effects of media, technology and artefacts than with the laws that governed them. Claiming not to provide a theory or history of media, he observed that his method was to devise “probes”—statements that would lead him to new paths of enquiry and discovery—that captured the effects of media technology. His style was discursive and exploratory, allusive and poetic. He was fond of quoting Stéphane Mallarmé (writing in 1886): “To define is to kill, to suggest is to create” ([McLuhan 1978](#b-9781474207935-023-0000140)). He preferred to use the public exposure of the lecture or television appearance to explore ideas rather than defend, test or discuss them.

McLuhan’s relevance to new media arts lies in his claim that the arts were a means of providing types of language that drew attention to the previous and current technological environment from which they emerged, and against which they could be contrasted. He accommodated a wide range of technologies, media and tools under the rubric of media, and he often identified commonalities between the arts and mass media (including advertising and television) owing to their shared status as media technologies and extensions of the human body, mind and senses. He contended that the arts, including literature, painting, poetry, film and architecture, drew on and rearranged the wider media environment that defined them. In the electronic period, since the Second World War, this environment was electronic and global, but it contained other environments, including ones defined by previously dominant media. To understand the position of the arts in McLuhan’s thought requires engagement with his observation that art constituted an “anti-environment” or “counter-environment” to the general technological ground from which it emerged, and in relation to other mass media (television or newspapers for example) that shared this ground. He attempted to define art as a separate field of practice and enquiry against other media technologies, by drawing attention to art’s ability to raise awareness of the effects of media, rather than attempting to confine their definition to a modernist reading. In the high-modern period of the mid-twentieth century, art had been defined as the hegemonic dominance of the aesthetic and philosophical interrogation of a medium into its unique conditions. Painting, for example, focused on its intrinsic properties of flatness, shape and material, leading to abstract expressionism and minimalism ([Greenberg 1961](#b-9781474207935-023-0000074)). McLuhan’s enquiry, however, was not constrained to one of the limits and preconditions of a specific medium. Instead, his understanding of art emphasized its connection to the technological field, in which, for example, one medium incorporated another, or different media expressed similar perceptual emphases. These ranged from the montage style of film, through the “radio” voice of radical literature, to the multi-perspectival techniques of cubism. The environmental field of technology encompassed modernist devices. It did not leave them isolated, entrenching themselves in their own areas of competence.

McLuhan approached art as a form of practice that foregrounded perception. He did so by embedding art in emerging and new media environments rather in isolation from them. He neither addressed art directly and independently—often describing the arts in plural and favouring literature as a means of gauging a medium’s response to, and effect on, the human environment—nor entirely reduced them to a technologically determined condition. Artists (novelists, painters, filmmakers, poets, architects, musicians, sculptors) had agency in his approach to understanding media, and he made many historical references to their artworks in order to illustrate his thesis on the perceptual awareness of the media environment that such new media arts evinced. Thus, in McLuhan’s world new media arts involve a far broader historical approach to the “new”. While he recognized the effect of new electronic technology on and through the arts, his historical frame of reference stretched far further back than the recent tendency to define new media arts through the computer, digital and network age of media.

## Defining Mcluhan’s New Media Arts

Understanding McLuhan’s relevance to new media arts requires an awareness of his quite extended definition of media, a clear sense of the role of the “new” in his approach to media transition, and the wide latitude afforded to the definition and practice of the “arts” as he conceived them: as responses to pervasive yet “invisible” media environments. Similarly, the role of art for McLuhan encompassed a wide range of media with respect to the specific effects and responses to the general media environment. For him, art was a relation between its sensory-intellectual field (the mind and senses organizing the world in experience) and the technological world of media. Unlike the dominant modernist tendency that treated art as a specific autonomous method of self-enquiry into each medium’s essential qualities, art in its effects brought to the foreground the imperceptible background of media technology. It did so by organizing pictorial, linguistic, material or sonic elements according to the emerging, prevailing or declining media environments and their interrelation expressed through their relative impact on human sense ratios. Each medium affected the senses proportionally, and to different degrees. Thus, for McLuhan, the replacement of oral cultures by writing and printing’s “ocular-centrism” altered the balance of sense ratios. Electronic media would stimulate all the senses simultaneously.

The definition of media in McLuhan is a broad one. Indeed, technology, media and tools in McLuhan’s analyses are often synonymous, including hardware, software, forms of communication and information processes. His study of media was not limited to mass communication but defined any artefact or system that is an extension of the human body and mind: wheels are an extension of the foot; knives an extension of teeth and nails; printed texts, the extension of the spoken word; television, the extension of the eye and ear; computers, the extension of the nervous system—“each new technology, be it house, or wheel, or radio, creates a new human environment” ([Gordon 2006](#b-9781474207935-023-0000071): 200). Therefore, there is a sensory, biological and psychological link between media and humans. Media are not reducible to their artefacts and technologies but are identified through their effects, “in terms of a larger entity of information and perception which forms our thoughts, structures our experience, and determines our views of the world about us” ([McLuhan 1975](#b-9781474207935-023-0000135): 75). McLuhan viewed all media and later all technologies as languages. Each one codified reality differently, and their effects rather than their meanings were their message ([Carpenter and McLuhan 1956](#b-9781474207935-023-0000060): 49). In contrast to the notion that a message comprised the content of a medium, “as people used to ask what a painting was about” ([McLuhan 1964](#b-9781474207935-023-0000113): 13), McLuhan insisted that the electronic era showed more clearly that the medium’s message was its social, psychological and sensory impact, defined as any extension of human physical or mental faculties that resulted from the new technology. The medium as message also meant not simply the succession of one medium or media ecological system by another, but the containment of the old medium as content in the form of the emergent and new one. The content of television, for example, was the movie. New media did not so much replace old ones as complicate them: “A new medium is never an addition to an old one, nor does it leave the old one in peace. It never ceases to oppress the older media until it finds new shapes and positions for them” ([McLuhan 2013](#b-9781474207935-023-0000146): 125). Art was involved in this same process of reorganizing earlier media. In doing so it shared with media transformation a capacity to alter sense ratios in humans, and between media. Art’s distinctiveness lay in its tendency to provide a counter-environment (a contradictory or contrasting form) to the prevalent media environment. Understanding how the arts achieved this requires a recognition of McLuhan’s emphasis on the changing ratios between the human senses, and on the senses construing the media themselves (such as the printed book, which privileges the visual sense).

## New Sense Ratios for New Media

McLuhan argued that new media affected the human senses and altered their ratios, and new media were themselves the result of pressure to extend the human body, mind, nervous system and senses into the environment. An extension of the human body (for example the eye and ear via telephone, or the foot with a wheel) resulted in what he called “auto-amputation”, a severing of the link between self and the medium. The myth of Narcissus, who lost his sense of self because he mistook his reflection for another person, was McLuhan’s favoured metaphor for this process ([McLuhan 2013](#b-9781474207935-023-0000146): 36). The structures of media altered and shaped human perceptions and sense ratios and had a numbing effect on humans because the pressure that a medium exerted resulted in a failure to recognize the medium as an extension of the self. McLuhan attempted to restore this recognition that media and senses are linked by drawing on Aristotle’s “formal causes”: just as for Aristotle a wax seal was formed by the seal itself so for McLuhan the media shaped humans through their use. McLuhan’s adherence to this tradition incorporated St Thomas Aquinas’s understanding of the senses and faculties of perception. Both insisted that only through careful examination of our senses could we discover how the world, and technologies, shaped ourselves. Media were always embedded with “sensory biases” that shaped human perception. The medium determined the modes of perception and generated the principles that dictated possible effects ([Berkman 2020](#b-9781474207935-023-0000055): 58). McLuhan viewed media as redistributing the balance and ratio among the five exterior senses, with media such as print mainly tending towards a visual bias, and radio or television leading to an audio-tactile one. His examination of the rise of typographic printing was an attempt to supply “the thing we do not know” ([McLuhan 1962](#b-9781474207935-023-0000110): 3) by revealing its unconscious effects on human perception. He contrasted its emphasis on the visual sense with the subsequent electronic age, which he found shared features with the oral and acoustic era prior to printmaking. The alphabet and printing gave a dominant role to the visual sense in art and language and drew attention to the shifting modes of awareness that changing technologies brought. Earlier “patterns of perception” persisted, however. Different media technologies across history induced different relations and ratios between senses, altering from closed systems separating our senses in the Gutenberg era (in which the early printing press and mass-produced books favoured vision), to a “single field” of experience introduced first by newspapers to vision then by electronic technologies through sight, sound and touch—the “all-at-onceness” of information. There was a corresponding transition in the dominant mode of sensation from the visual to the “audile-tactile”. Printing privileged the visual sense and was an abstraction of embodied speech: “With print the eye speeded up and the voice quieted down” ([McLuhan 1962](#b-9781474207935-023-0000110): 43). In ancient and medieval societies all reading had been reading out loud, but modern reading was now an inward process.

New media gave rise to altered sense ratios, but they did this “not only among our private senses, but among themselves, when they interact among themselves” ([McLuhan 2013](#b-9781474207935-023-0000146): 44). The introduction of radio altered newspaper news stories, and changed the film image in sound movies (“talkies”). Television affected radio programming, and “TV, with its deep-participation mode, caused young poets suddenly to present their poems in cafes, in public parks, anywhere. After TV, they suddenly felt the need for personal contact with their public” ([McLuhan 1964](#b-9781474207935-023-0000113): 53). The interaction between media also led to a medium absorbing an emergent one to provide a new mode of content. For example, the early nineteenth-century newspaper page was constructed like multiple book pages on a single sheet (thus mirroring a previous technology); but with the arrival of the telegraph this content became instant and global. Alphonse Lamartine had seen the decline of the book with the arrival of newspapers in 1830 ([McLuhan 1969](#b-9781474207935-023-0000129): 5). However, the radical literature of Joyce in *Ulysses* and Eliot in *The Waste Land* transformed the book by introducing new content from other media into its form, producing non-narrative epics that used the newspaper and radio content of fragments, non-linear, multi-directional montaged “voices” and headlines. Thus, the arts (in this case literature), responded to new media technology by absorbing its content ([McLuhan and Watson 1971](#b-9781474207935-023-0000167): 38). Likewise, theatre, exemplified by the plays of George Bernard Shaw, took on human interest stories once confined to the press, until in turn the movie and then TV digested them. Mass media, therefore, exerted its effects on art: for example, the newspaper format had revolutionized poetry, including the poet Rimbaud’s “verbal landscapes”. McLuhan saw the need to connect technology, mass media and art, proposing that “To get at Rimbaud and modern art it is not merely desirable but quite necessary to study the effect of the telegraph on the press and of both on poetry, painting and music” ([McLuhan 1956](#b-9781474207935-023-0000108)).

## New Media and the Arts as Counter-Environment

For McLuhan media environments were active processes rather than passive “wrappings” ([McLuhan and Fiore 1967](#b-9781474207935-023-0000149): 68). These environments not only included new content, which the human received as message, but also imposed a structural, “deep” transformation in the engagement between the human and the world. This impact was necessarily mitigated because of the potential trauma caused by a conscious encounter of the human sensorium with the new environment. The invention and effects of a new technology led to an initial shock, “a vigorous new ‘closure’, or novel pattern of interplay, among all of the senses together” as it altered sense ratios ([McLuhan 1962](#b-9781474207935-023-0000110): 22). This shock dissipated as the community adapted to a new habit of perception, whereby the alphabet, printed book or radio opened a new role for the eye or ear, and different interplay between senses. Following Freud, McLuhan attributed to learning or immersion in media a role for censoring and selection: “were we to accept fully and directly every shock to our various structures of awareness we would soon be nervous wrecks” ([McLuhan 2013](#b-9781474207935-023-0000146): 24). Rather than simply carry messages that the human recognized, emerging media were imperceptible because they arrived as “background”. Humans perceived their content (“meanings”), but this was in general a retrospective action, which McLuhan called the “rear-view mirror” engagement with media ([McLuhan and Fiore 1967](#b-9781474207935-023-0000149): 75). The content of the new environment, in this case the electronic one that arrived in the mid-twentieth century, was the prior environment, here the mechanized environment of the previous industrial period. With particular media, such as TV, there was a reprocessing of earlier media: writing in 1964 McLuhan said “For the content of the TV is the movie. TV is environmental and imperceptible, like all environments. We are aware only of the ‘content’ or the old environment … Each new technology creates an environment that is itself regarded as corrupt and degrading. Yet the new one turns its predecessor into an art form” ([2013](#b-9781474207935-023-0000146): 10). Here we can see the two-fold role for art in McLuhan’s model: it prepares for the trauma of the incoming emergent media by bringing its effects to consciousness, or it transforms earlier environmental technological grounds into art. It therefore has a retrospective and anticipatory dimension. In this sequential context, McLuhan considers art a combination of two responses which may arguably be labelled conservative and progressive.

The conservative response is the chronological or temporal process by which the new medium incorporated the former one as “art”. It is the process by which a new technology turns its precursor into its content as an art form that signals the location and function of the arts. McLuhan stated that these new modes were not immediately recognized because humans retain previous patterns of perception.

In the arts this rear-view mirror process features historically across periods and styles, so that content comprised or reprised themes from the preceding ages. For example, “the Pre-Raphaelites adapted Medieval content for Romantic forms of treatment. And the Romantic poets, rejecting the new industrial environment, seized as their content the preceding agrarian environment of nature and the handicrafts” ([McLuhan and Parker 1968](#b-9781474207935-023-0000161): 21). They also employed impressions of external landscapes to invent, explore and define mental states ([McLuhan 1956](#b-9781474207935-023-0000108)). The arrival of railway and machine created a new environment for agrarian society, and nature became the work of art; and when the electronic circuit entered this mechanical environment, the machine developed into the subject. Abstract art, Dada, Futurism and, later, Pop Art were its results ([McLuhan and Parker 1968](#b-9781474207935-023-0000161): 252). The preceding media environment became the content of the new one, with art as the destination: “Obsolescence is not the end of anything; it’s the beginning of aesthetics, the cradle of taste, of art, of eloquence and of slang” ([McLuhan and McLuhan 1988](#b-9781474207935-023-0000155): 100). Here, the new media art was the conservation of the previous environment at the level of content (or “figure”) rather than form, pattern or “ground”. McLuhan’s use of “figure” and ground’ derives from Edgar Rubin’s Gestalt psychology, but he applies it to technological environments rather than visible phenomena ([McLuhan, Hutchon and McLuhan 1977](#b-9781474207935-023-0000152): 9).

Paul Levinson, the media theorist and McLuhan’s former student, asserted that aesthetics and art were the final stage of a new medium’s arrival. The new medium began as a novel toy or gimmick, entered a phase where it acted as a “mirror” to reality, then became an art form, where it developed its aesthetic language. The movies, for example, were initially a fascination with process and technological possibility (such as the single-shot film *Fred Ott’s Sneeze* of 1894), then a means of recording the world, and finally a medium with its own specific techniques and aesthetics as a popular art form: “the edit of course proved to be the key in the transformation of film from reality transcription to popular art” ([Levinson 1977](#b-9781474207935-023-0000085): 158). Film removed itself from reality to create its own transcendent but understandable grammar.

Conversely, in progressive terms, the arts in new media were “anti-environments” or “counter-environments” and a means of perceiving the environment itself. McLuhan drew on Ezra Pound’s idea of the artist as antenna of the race ([Pound 1934](#b-9781474207935-023-0000176): 73). The artist was the early-warning system, alerting society to the environment it was entering: “All the warning signals of the new ground are present in the arts long before the hardware boys ever feel them” ([McLuhan 2005](#b-9781474207935-023-0000143): 220–21). Quoting correspondence from his friend Wyndham Lewis, McLuhan stated the artist was less endowed with power of foresight than being “engaged in writing a detailed history of the future because he is aware of the unused potential of the present” (ibid.: 14). Using the metaphor of recent wartime technology, McLuhan likened the arts’ role to a “radar environment”, which provided an “indispensable perceptual training rather than a role of a privileged diet for the elite” ([McLuhan 1964](#b-9781474207935-023-0000113): xiii). However, he was careful not to associate the arts’ ability to identify and use the environmental cues provided by new technology and media with the ability to change it, but simply to continue its progress towards designated goals despite the disruptions, he noted, technological innovations brought to society. McLuhan therefore considered that changing goals as often as technologies altered was futile. He presumed a constant line of development towards a destination in the future, predicated on the arts’ capacity to provide a perceptual compass despite the vortex of technological change.

McLuhan interpreted the reaction of the arts to technological transformation of the environment as a direct involvement with the mode of perception that new media and technology introduced. In *Through the Vanishing Point*, he noted that in the electronic media environment, “where all-at-onceness is inevitable and normal”, the arts discovered an affinity for discontinuous modes of perception (rather than what he called the “lineality” and detachment of the written word, or the inner “visual” mode of radio listening). He proposed that early modern artists, including Gauguin and Picasso, produced art that “anticipated the discontinuous electronic modes of perception by their immediate awareness of the new environment” ([McLuhan and Parker 1968](#b-9781474207935-023-0000161): 21–2). Seurat’s Pointillism anticipated the spaces of TV, which composed colour as “light through”. Pointillism mixed colour optically in the sensorium of the viewer, rather than as “light on”, as is the case with cinematic projection of light. Rather than primarily visual, like a photograph, the colour of TV was received as a mesh of dots, with light shining through them with varying intensity to allow the image to form. The viewer acted as a screen, rather than as a projector. For McLuhan television broke with the dominance of the visual sense. It involved “a convulsive sensuous participation that is profoundly kinetic and tactile” ([McLuhan 1964](#b-9781474207935-023-0000113): 314). For McLuhan this immersion of the viewer defined a “cool” medium. Unlike a hot medium, such as a photography or a book, which “extends one single sense in high definition” so that there is less to “fill in” by the viewer, a cool medium (such as a seminar or a dialogue) increased participation. While there was no physical contact between viewer and television, the eye was more intensely involved with the screen than with print, so that the effect was the same as touching. Reacting to the altering sensory ratios that new media technology introduced, artists explored new environments, often redeploying the technology of traditional media. New, electronic media generally shared these “cool” characteristics of involvement, immersion and participation.

The anticipatory impulse was also present in ways that reverse art’s anticipation of new media, because mass media often pre-empted modern art. For example, newspaper layouts in the age of the telegraph, in their fragmented presentation of news, advertising and editorial, anticipated the montage effects of later modern art, such as Dada. Conversely, formerly “avant-garde” methods in art, returning to Rimbaud’s montage poems, became the “old environment” by 1911 ([McLuhan and Parker 1968](#b-9781474207935-023-0000161): 189). At any moment in time the arts responded to other media, and mass media often pre-empted them; but artists in McLuhan’s terms brought these unnoticed effects to general awareness.

## Art and Environment as Total New Media

McLuhan had a tendency to blur the boundary between the arts and the media environment, grounded on the intricate relation between the human senses and the sense ratios imposed by new media and reflected in the arts. His elision of the distinction between art and environment operated between the arts as a specific social enclave, and later as an avant-garde practice. First, art was separate from environment because it provided a separate and specific type of perception for an elite (later termed the “art world”). This was compounded by its role as a counter-environment in its avant-garde version, where it offered an alternative version to the environment using radical forms. This was a separation in either case. However, according to McLuhan, this was occluded when technology was extended to the entire environment to the point where it enfolded nature and world to transform them both into the content of media. The paradigmatic example was satellite communications technology, which, in surrounding the planet, transformed Earth from a background environment into an active “probe” or experimental site. The arts changed from their isolated status as anti-environments to content of the wider probes of mass communications technology: Now that the planet was the content of technology it was also a work of art. Whereas modern art formerly turned the “package” of the environment into its own probes (such as the techniques of symbolist art that “broke up” the world and “threw it together” to make the world visible in its own assembled terms) the environment at large was now programmable, for “satellites and broadcasts from the moon make it quite as natural to think of the entire planet as a work of art” ([McLuhan and Watson 1970](#b-9781474207935-023-0000164): 199). Likewise, thus enfolded, all new media were art forms “which have the power of imposing, like poetry, their own assumptions” ([McLuhan and Parker 1970](#b-9781474207935-023-0000164): 52). Even the newspaper was an art form, but required an alert user to see that “the front page of a newspaper is a superficial chaos which can lead the mind to attend to cosmic harmonies of a very high order. Yet when these harmonies are more sharply stylized by a Picasso or a Joyce, they seem to give offense to the very people who should appreciate them most” ([McLuhan [1951] 2011](#b-9781474207935-023-0000105): 16). Thus McLuhan’s expansion of art into the environment, and the interplay of media as arts, still confronted a barrier central to his thesis. This was the need for awareness of the media’s effects to reveal affinities between the organization of sense ratios in their composition (for example montage and parataxis) across apparently quite diverse media: the press, and modern art and literature.

In McLuhan’s model, media and world were synonymous, and there was no environment outside the media (nature having been subsumed as content in the machine age and the electronic age). Yet, the arts were a particular type of environment, depicted as a total programme of manipulation or counter-environment, instantiated in a variety of ways and at different scales. For example, television could be considered part of the arts, but so too could a specific avant-garde use of televisions. New media arts were not means to connect humans to an old “real” world; they *were* the real world, and they reshaped the old world as their content. Finally, McLuhan declared that, like science and philosophy, all the arts were anti-environmental controls that were always merging with the environments, and “losing their power to create awareness of environments” ([1970](#b-9781474207935-023-0000164): 31).

McLuhan noted the effects of the increasing speed of media transformation: technologies and their consequent environments succeeded each other so rapidly that one environment made its users aware of the next one. In this increasing rapidity, technologies began to perform the function of art, drawing humans’ attention towards the psychic and social consequences of technology. Art as anti-environment became more than ever a means of training perception and judgement, not as a privileged mode of perception for an elite but as participation in a common life or environment, in which “we are extending the privileged artefact principally to the environment itself” ([1970](#b-9781474207935-023-0000164): 32). The environment was now the artefact, and aesthetics was the extension of creative action and sensibility to the environment as technology and media. Both were afforded the same attention. To express this McLuhan deployed a supposed Balinese adage: “We have no art, we do everything as well as possible” ([1970](#b-9781474207935-023-0000164): 118). Art was no longer separate or transcendent when it was part of the human transformation of the environment, organized through the same sensory and intellectual channels.

## Mcluhan’s Future—New Media Arts in the Electronic Networked Era

McLuhan’s futurology was constrained by the imaginative possibilities afforded by the technologies of his era: his own rear-view mirror. For example, in 1964 he imagined film would surpass its “manuscript phase” and move to a “portable, printed-book phase”: “Soon everyone will be able to have a small, inexpensive film projector that plays an 8-mm cartridge as if on a TV to screen” ([1964](#b-9781474207935-023-0000113): 291–2). He saw the contemporary disconnection between projector and screen as a vestige of the explosive mechanical world, and their future convergence a feature of “electrical implosion” (ibid.: 322). He also considered film a meta-medium, in which the content of film is “a collection of media within media, the ‘message’ is all of them at once”). While “film” in McLuhan’s time had this role, recent digital convergence has made film itself the content of electronic environments, film (now the “moving image”) being the content of coding across multiple platforms, services and interfaces. McLuhan’s speculations touched on the interactive aspects of transactions between user and information, but remained couched in the available technology:

When computers are properly used, in fact, they are almost certain to increase individual diversity. A worldwide network of computers will make all of mankind’s factual knowledge available to students everywhere in a matter of minutes or seconds … New materials may be learned just as were the great myths of past cultures – as fully integrated systems that resonate on several levels and share the qualities of poetry and song.

— ([McLuhan and Leonard 1967](#b-9781474207935-023-0000124): 23–4)

In *Through the Vanishing Point* McLuhan asked, “What kinds of art could serve today to probe and reveal the hidden dimensions of the electronic world?” ([McLuhan and Parker 1968](#b-9781474207935-023-0000161): 73). According to his famous adage, the world was now a “global village”, a universal community partly realized through satellite telecommunications, long-distance telephony and live TV news. Yet this village was not global (TV was predominantly a national medium) and not interactive, as the “villagers” could not all talk to one another. McLuhan, however, identified participatory involvement in an electronic environment where art and technology extended and combined in revolutionary ways. While not predicting the digital network society McLuhan recognized the implications of computer-based media in the context of “Art as Survival in the Electric Age”: “The time is now ripe for a completely new breakthrough in the arts” ([McLuhan 2005](#b-9781474207935-023-0000143): 218). McLuhan had thought that art had reached its extreme in “Happenings”, highly planned and participative performance events initiated by artist Allan Kaprow. The Happening turned the environment into an art form of action and involvement. McLuhan also included Pop Art as another radical development, which in its banality turned the environment into a “quasi art-form”. He made a link between this art and “an electronic world in which the programing of whole environments by information is as feasible as the earlier programming of classrooms” ([McLuhan and Parker 1968](#b-9781474207935-023-0000161): 30).

McLuhan’s position on new media arts, although indirectly expressed, involved the expansion of art into the electronic environment, and an increased level of participation and interaction; but new media were not disposed to adopting a radical interrogation of their status as technological messages in themselves. Rather, they functioned as “aesthetic parasites in relying upon other media for creativity and art” ([Levinson 2001](#b-9781474207935-023-0000090): 163). By the mid-1960s, however, McLuhan’s message was being received by new media artists who drew attention to the messages of media themselves rather than their parasitical content. Nam June Paik’s art of video, TV and performance drew directly on the Canadian’s image to produce a TV artwork, *Demagnetizer (Life Ring)* (1965), which used a powerful magnet to deform McLuhan’s televised face. Paik remarked on the link between Happenings and Norbert Wiener’s concept of cybernetics, from which he thought McLuhan had taken the link between “media is message” and Wiener’s “The signal, where the message is sent”. For Paik, Happenings fused various arts, in the same way as cybernetics exploited boundaries between sciences, in which humanity exists “in open circuits” and media exerts feedback between signal and message. Paik’s *Global Groove* (1973) further exploited the raw material of media—the television signal itself—as the content of art ([Paik 2001](#b-9781474207935-023-0000170): 41).

McLuhan’s maxim that media were extensions of the body, mind and senses, reflected in the cybernetic feedback loops of the (artist’s) body and machine, and present in the triggering of a video or music sequence by a gesture or glance, has been likened to the “outering” of the human nervous system as “extensions of man” ([Dixon 2015](#b-9781474207935-023-0000065): 147). Stelarc, the artist who turned his body into an extension of the machine (and vice versa), shared McLuhan’s resistance to the ideology of disembodiment implied or effected in the transition to an electronic world in which the body disappeared. McLuhan, who believed in the abiding importance of incarnation, said, “As electric media proliferate, whole societies at a time become discarnate, detached from mere bodily or physical ‘reality’ and relieved of any allegiance to or a sense of responsibility for it … The alteration of human identity by new service environments of information has left whole populations without personal or community values” ([McLuhan and Watson 1970](#b-9781474207935-023-0000164): 379).

The changing ratio of sense perception that occurred with a new medium was also a technological extension of those senses in the new media. For McLuhan, computers could be programmed for all varieties of sense ratio, so that we could determine the “cultural assumptions” that would arise on, presumably, altering the colour balance or volume on a television broadcast ([1962](#b-9781474207935-023-0000110): 183). Written in 1962, this anticipated how recent digital technologies can change ratios between senses, allowing us to read online, write messages, watch TV programmes and make video calls on one device.

## Conclusion

McLuhan’s conception of the arts and media environment has received criticism during and since his heyday. Critics alleged his work was compromised by his eager collaboration with corporations, and his relatively apolitical stance. His approach to society and culture was “conservative postmodern”, rather than anti-capitalist, and rather than embracing the freedoms of the electronic age he favoured the possibility of a return to a society valuing community over individuality ([Havers 2003](#b-9781474207935-023-0000077): 515). His ascriptions of different sense ratios to different cultures can be read as reflections of the racial, sexual and gender biases of his own background. McLuhan’s view of the arts, and new media arts, holds conservative and progressive impulses in tension. This suggests a dynamic that refutes the claim that McLuhan was a wholesale advocate of the electronic media revolution. He resisted this interpretation: “I am resolutely opposed to all innovation, all change, but I am determined to understand what’s happening” ([McLuhan 1966b](#b-9781474207935-023-0000121)). The emancipatory aspects of his work were attempts to retrieve a traditional, organic community beyond the individualistic marketplace brought about by print technologies, and he was not attracted to revolutionary visions of a new social order. In his view of the arts, the progressive tendency would bring to awareness the effects that a new media environment exerts on humans, and the traditionalist one would focus on prior or external media as content. Both were arguably constrained by McLuhan’s detachment of art from a political project, and his adherence to a traditional conception of art as device to detect or anticipate change rather than instigate or be involved in it. This was expressed in his dictum, “Art is anything you can get away with”, which suggested that art’s purpose was to test the limits of the environment but not intervene or critically comment on it. Yet there remained a role for resistance and challenge in McLuhan’s artist of new media: the “serious artist” opposed those who “have made it a full-time business to get inside the collective public mind … in order to manipulate, exploit, control” ([McLuhan [1951] 2011](#b-9781474207935-023-0000105): v). The artist also challenged “official art” to develop a counter-environment that would “restore cognitive and sensorial awareness” ([McLuhan 1966a](#b-9781474207935-023-0000116): 56).

McLuhan’s thought pre-dated digital, network and social media, and the contemporary forms of art and mass media environments of the early electronic and communications technology of the 1960s, but his holistic view of art and new media perhaps anticipated the increasing interpenetration of technology and aesthetics in the digital age. New media art has been redefined with the advent of computer technology and networked digital media ([Manovich 2002](#b-9781474207935-023-0000096): 19). In the face of the persistence of traditional art forms, electronic and digital technology are now more integral to recent art practice, in video and computer art, as well as the use of programming and digital content in installations, virtual environments and interactive exhibits. New media art points to practices conducted outside the contemporary art world and art market with scientists, activists and technology research centres involved in a “transitional, hybrid art form, a multi-disciplinary ‘cloud’ of micro-practices” ([Lovink 2007](#b-9781474207935-023-0000093): 41). They emerge across mass media and data processing, and between artists and software developers. McLuhan highlighted the common ground of media technologies and art’s aesthetic strategies in the 1960s, in his references to Jackson Pollock’s paintings, Joyce’s novels and Kaprow’s Happenings. More recently, the hypertext of the web exceeded James Joyce’s media-layered novels, interactive art embraced the touchscreen and mouse, and avant-garde filmmakers use software such as After Effects and Final Cut Pro ([Manovich 2003](#b-9781474207935-023-0000099): 15). These were outcomes that McLuhan did not live to see and probe, but were arguably the descendants of the principles of the simultaneity of sensory awareness and perception that he attributed to the electronic age, in contrast to the detached, fixed and linear point of view of the age of printing and the book.

While McLuhan’s ideas were not built on projections into the future his “tetrad”, which he first published in 1974, is capable of being applied to all media including those which have appeared after his death. The tetrad comprised four laws of media which addressed what a device or tool would “obsolesce, retrieve, enhance or amplify, and reverse into—in no particular order”. On a broad scale, for example, his tetrad for “mass media” amplified the planet to a single theatre, obsolesced private identity and bodily presence, retrieved the occult (the hidden) and at its limit reversed or “flipped” hardware into software: “everything is everywhere at once” ([McLuhan and McLuhan 2017](#b-9781474207935-023-0000158): 132). McLuhan invited his readership to construct their own tetrads. If the four laws were applied to current “new media art”, it arguably obsolesces art as counter-environment, it amplifies the planet as the gallery, it retrieves the arts as an involved activity (audience as participants), and it flips at its extreme into socio-cultural research technologies, corporate marketing tools and the development of intellectual property assets.

In this respect McLuhan defined the electronic era as an acoustic or auditory rather than primarily visual environment in which the boundaries between the arts themselves, and between the arts, sciences and commerce, had vanished. In his understanding the new media were applicable neither to the few nor the studio, but to “cities and to whole regions”. New media arts’ electronic grounding suggests this extension through the current technological environment removed art’s critical distance or distinctiveness, but despite this he still held to the value of an educative role of the arts. Formerly reserved for “scholars and geniuses”, he recognized them to be “a character of all human perception” ([McLuhan 1956](#b-9781474207935-023-0000108)), and available as a form of environmental programming that would alert humanity to the effects of media and technology. McLuhan’s probes and insights arguably invite new media arts to reveal the sensory imbalances and shocks they trace and mass media and technology impose, and interrogate their role as warning systems that anticipate future environments or reveal the sensory, psychological, social and cultural impact of those in the present.

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Jack Wesley Burnham (Jr.) (1931–2019) was an American artist, critic, theorist and educator who came to prominence in the 1960s. Initially influenced by the programme of the refounded Chicago Bauhaus but subsequently breaking with its precepts, Burnham’s artistic, historical and theoretical work focused on the interrelation between art, science and technology in light of the post–Second World War information technology revolution and the associated development of an information society. In particular his writing addressed the supersession of sculpture as an artistic medium and the introduction of new non-traditional media into the artistic field. In the late 1960s he produced an account of art that embodied a “systems aesthetic”, framing his theory in socio-cultural terms that were indebted to the New Left’s coeval critique of technocratic society. Burnham’s innovative work sought to theorize the post-medium-specific and post-object-specific character of postformalist art in terms of a relational ontology. His work was, however, marked by an often awkward elision of humanistic and scientific traditions of thought that remained theoretically unresolved. He came to renounce his advocacy for the synthesis of art and advanced technology in the 1970s in light of his conviction about the historical failure of this project and his later writing was marked by an esoteric turn that disqualified it from conventional academic validity.

Burnham’s original but uneven and mercurial body of work long eluded mainstream art-historical acceptance. It saw renewed interest from the late 1990s onward, however, where it has once again come to seem relevant in light of the cultural and socio-technical developments consequent upon the advent of mass personal computing and the wide-scale adoption of the internet. Burnham’s systems aesthetics was initially re-evaluated by new media theorists and historians and subsequently by art theorists and art historians (against a backdrop where such categorical disciplinary distinctions have themselves softened). Issues that Burnham discussed in his writing that remain live today include: the need for a coherent ontology of contemporary art; his attention to the fraught relationship between art and technology (a major fault line in contemporary culture); the artistic relevance of systems theory and cybernetics (both in the historicization of late modern art and for contemporary art theory); his engagement with, and mobilization of, the aesthetic tradition beyond the narrow reading of that tradition that characterized historically influential formalist theories of art; and his consideration of the use of artificial intelligence and biological engineering in and as art. Notwithstanding its limitations, Burnham’s attention to the relational ontology of post-medium-specific contemporary art was pioneering and his politicized project to think the humanities and the sciences alongside each other has proved highly prescient.

## Biography

Burnham was born on November 13, 1931 in New York City. He grew up in Quincy, Massachusetts, where he attended North Quincy High School, graduating in 1949. After graduating from high school Burnham spent four years in the US Army at Fort Belvoir (1949–52) in the drafting school of the Corps of Engineers. Burnham served in Okinawa, Japan, and New York City but did not see active combat in the Korean War (1950–53). He received an honourable discharge from the army in 1952 and subsequently began artistic training at the Boston Museum School of Fine Arts that year, majoring in commercial design and silversmithing, with minors in sculpture and painting. While in Boston Burnham struck up an influential friendship with the Soviet Constructivist artist Naum Gabo, who was then teaching at the Graduate School of Design at Harvard. Unconventionally, Burnham divided his studies at the Boston Museum School into two phases—1952–4 and 1956–7—and during the intervening two years, he studied for an engineering associate’s degree in architectural construction at the Wentworth Institute in Boston in 1954–6. In combining training in art and engineering Burnham emulated his mentor Gabo. Burnham subsequently went on to study at the Yale School of Art, taking a bachelor’s of fine arts in 1959 and a master’s of fine arts in 1961. In all these respects Burnham’s education and training was distinctively hybrid in nature, combining as it did art and the applied sciences, the “practical” and the “fine” arts.

Burnham worked as an artist from 1954 to 1968, supporting his practice by a mixture of full- and part-time employment as an architectural draftsman and designer (1957–8), as a corporate sign fabricator and painter (1956–68), and, predominantly, as an educator (1959–68). Burnham participated in several group shows in the US from 1957 onwards (with most between 1965 to 1970). He also had five one-man shows from 1965 to 1969 but none of his solo shows (and only one of his group shows) were in New York and his career as an artist did not take off in a major way. Burnham joined the faculty of Northwestern University in 1964 as an assistant professor of art, having previously served as an instructor at Yale, Wesley College and Northwestern from 1959 to 1964. Between 1968 and 1969 Burnham undertook a one-year fellowship at the Center for Advanced Visual Studies (CAVS) at MIT under the directorship of the Hungarian émigré artist György Kepes. Burnham achieved tenure at Northwestern and progressed from assistant to associate professor of art in 1969. He stopped active work on his artistic practice after his CAVS fellowship and from then on worked principally as an art educator, theorist and critic. He was a contributing editor at *Artforum* (1971–2), an associate editor at *Arts* (1972–6) and a contributing editor to *New Art Examiner* (1976–1983). In 1970 Burnham guest curated the major group exhibition “Software—Information Technology: Its New Meaning for Art” at the Jewish Museum in New York, where he presented the work of leading artists and leading technologists alongside each other.

Burnham wrote two major books in his career: *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century* (1968) and *The Structure of Art* (1971). He also produced a short theoretical monograph on the US-based, German philosopher Herbert Marcuse which was published as the pamphlet *Art in the Marcusean Analysis* (1969). He authored numerous articles, interviews and reviews published from 1964 to 1990 (with the great majority appearing from 1964 to 1981) in art magazines including *Artforum*, *Arts*, *The New Art Examiner* and *Art in America*, or as chapters in collections. In 1974 Burnham republished a selection of these articles, written up to 1973, in his 1974 volume *Great Western Salt Works: Essays on the Meaning of Post-formalist Art*. Burnham wrote several important catalogue essays (including monographic studies of the German-American artist Hans Haacke, the Soviet artists Vitaly Komar and Alexander Melamid and the French-American Marcel Duchamp). Burnham also worked on a projected monograph interpreting the art and writings of Duchamp from 1973, receiving a Guggenheim fellowship (1973–4) for the project. Burnham did not ever publish or complete the book on Duchamp but it was outlined in a series of articles on the artist written from 1971 to 1973 for various art magazines (some of which were collected in *Great Western Salt Works*). Burnham became full professor of art at Northwestern in 1974. Subsequently, he moved to the University of Maryland in 1982 as chair of the art department, where he taught until his retirement. Much of Burnham’s later critical work engaged various esoteric traditions (principally Kabbalah) in ways that distanced it from traditional academic legitimacy. The most prolific period of Burnham’s career as a theorist was thus relatively compressed, running from the mid-1960s to the mid-1970s. An anthology of Burnham’s writings entitled *Dissolve into Comprehension* appeared in the MIT Press’s “Writing Art” series in 2015. Burnham died in 2019 at the age of 87.

## Kinetic Art Practice and History of Modern Sculpture

Although he is now best-known and remembered as a theorist, Burnham started his career as an artist (initially identifying as a Constructivist and subsequently as a Kineticist) and taught in art departments throughout his career. Burnham’s theoretical, critical, historical, pedagogical and curatorial concerns stemmed from issues that he addressed originally in his practice. His artistic work was shaped by his early interaction with the deradicalized Cold War version of Constructivism that Gabo propagated abroad and more widely by his engagement with the reformulated post-war terms of the historic avant-gardes as they were influentially disseminated in the United States—again in deradicalized form—via the “New Bauhaus” founded in Chicago in 1937 by the artist and Bauhaus master László Moholy-Nagy and shortly joined by two further Bauhaus Dessau teachers, Hin Bredendieck and György Kepes. Following the death of Moholy-Nagy in 1946 the New Bauhaus Chicago was incorporated into the Illinois Institute of Technology in 1949 and renamed the Institute of Design. Burnham acknowledged that his own interests in Constructivism and luminous art could be traced to a design course that he took at the Institute of Design in the early 1950s, led by one of Moholy-Nagy’s and Kepes’ protégés, and that this was further entrenched by a seminar that he took in 1957 on light as an art form given by Kepes to architectural students at MIT. Burnham also went through Joseph Albers’s form of Bauhaus pedagogy in the BFA and MFA that he took at Yale. Thus while Burnham did not take any of his formal degrees from the New Bauhaus he modelled his artistic formation very much in the spirit of its reformed incarnation in the post-war US, incorporating as it did specialized scientific and technical training alongside more traditional instruction in art and design in ways that were no longer opposed to liberal capitalism but rather accommodated to it.

Burnham’s early exposure to, and engagement with, the Bauhaus and related ideals under the Cold War pressure of political neutralization profoundly shaped the subsequent development of his artistic practice and thinking. Burnham’s artistic formation was distinctively New Bauhausian, in both its Moholy-Nagian design-focused and Albersian liberal arts inflections. And this Bauhausian formation determined the artistic problems that he addressed in his early practice as a sculptor. In his earliest mature work from 1954 Burnham experimented with the use of incandescent light as back lighting for cardboard and wood reliefs before beginning to experiment, from 1955, with the use of neon light, often arranged in hanging constructions that moved away from relief form. Subsequently, from 1959, Burnham began to explore light and motion phenomena, or what he called photo-kinetics. Such works included light walls that employed the principles of apparent motion, colour-modulating consoles that employed fibre-optic wires and subsequently, from 1966, light environments that employed programmed electronics and computer components to control timed light (sometimes in response to sound cues).

The development and character of Burnham’s kinetic artistic practice has therefore to be contextualized in relation to modernism understood in terms of the New Bauhausian attempt to reconcile scientifico-technical and artistic culture under US capitalism. Yet by the latter stages of his relatively short artistic career these commitments led him to break with the artistic positions of both Gabo and Kepes. By the time he had begun his one-year fellowship at CAVS with Kepes in 1968 Burnham was on his own account in revolt against Kepes’ New Bauhaus philosophy as well as trying to get away from the Constructivism of Gabo. A particular concern here was what Burnham took to be the failure of the New Bauhaus, and specifically Kepes, to keep pace with the advanced computerized technology that was then defining the emergence of a so-called second machine age. Such a position, for Burnham, automatically sacrificed the possibility that art might contribute to the progressive reorientation of advanced technology and thus ultimately undermined the very principles that animated (New) Bauhaus-derived modernism. During his fellowship Burnham consequently spent time collaborating with computer scientists on his own artistic practice, making a programmed light environment that employed electroluminescent tapes and working on an essay on the use of computers in art.

The artistic works using electroluminescent tapes represented the concluding moment of his artistic career: Burnham stopped making art after his CAVS fellowship, acknowledging that he was not able to sell any of these works and thus that they were a commercial failure. Burnham’s subsequent cessation of his practice also strongly suggests that he did not consider the works to be an artistic success either. An issue here was the way in which these works seem to fail to undertake the progressive reorientation of advanced technology that Burnham’s own personal commitment to update New Bauhausian ideals entailed. The electroluminescent tapes that Burnham employed in these works were made by the Sylvania Corporation and were predominantly used by the military for instrument panels, safety lights and temporary helicopter landing beacons in Vietnam. In light of the New Left’s critique of the Vietnam War and the US’s position within the global Cold War—a critique that Burnham was well-aware of and sympathetic to—these works can be seen as constructions that did not gain sufficient critical purchase on their material/*matériel*. Here Burnham did not seem able to enact his self-declared, counterculture-inspired “revolt” against Kepes’ and broader New Bauhaus principles at the level of his own artistic practice.

The development and cessation of Burnham’s own practice, understood in relation to his early embrace, and later rejection, of New Bauhausian currents afford us insight into the character and stakes of the critical, historical and theoretical writing that Burnham would ultimately gain most recognition for. Burnham’s first book, *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century*, was completed in 1967 but not published until 1968, and ran through five editions between its first publication and 1978. The book received an equivocal critical reception, however. It was a pioneering attempt to articulate a history of the development of modern sculpture in relation to the development of modern science and technology in light of the Marxian critique of the process of reification within capitalist society. The book provided a materialist and avowedly technologically determinist history of modern sculpture from the 1870s to the 1960s and acknowledged a methodological precursor in the work of the German architect Gottfried Semper. Burnham insisted on his commitment to Semper’s notion of *Kunstmaterialismus* (artistic materialism), which had been critiqued by the influential Austrian art historian Alois Riegl and to which he had counterposed his concept of *Kunstwollen* (artistic volition). For Burnham, Semper productively stressed the fact that art was a reflection of the economic, technical and social relationships that prevailed within a given society and he rejected what he took to be Riegl’s overemphasis on the role of spiritual forces in the shaping of art. Instead Burnham insisted on the necessity of achieving new spiritual insights into materialism and asserted that his book undertook such a project in light of the close analysis of the development of one art form.

Burnham’s account of the development of sculpture was teleological in the classically modernist sense in which modern art was understood to progress in a future-directed manner by continually negating the character of prior art. He distinguished between an earlier and residual conception of “sculpture as object” and what he discerned as a later, still-emergent, conception of “sculpture as system” (defined as an interacting assembly of varying complexity; [Burnham 1968a](#b-9781474207935-024-0000063): 19–181; 184–376). Burnham argued that kinetic art originated the transition from object-based to systems-based sculpture and developed his notion of sculpture-as-system in dialogue with the theorization of systems that had been developed in the disciplines of cybernetics and general systems theory (both of which had directly influenced the work of various kinetic artists that Burnham discussed; [Burnham 1968a](#b-9781474207935-024-0000063): 218–84). At the conclusion of *Beyond Modern Sculpture* Burnham predicted that sculpture would eventually evolve into a living system (thus collapsing the separation between the representation and the production of life in the sculptural tradition), in concert with the broader emergence of a posthuman future in which synthetic life would dominate organic life (ibid.: 376). In the course of his analysis Burnham undertook a pioneering proleptic evaluation of the likely evolution and significance of the emerging discipline of artificial intelligence.

At a more local level *Beyond Modern Sculpture* also contextualized the artistic problems that Burnham had been working with in his own art practice, as can be seen from the fact that he included a brief description of his own work within his broader history (included in his chapter on “Light as a Sculpture Medium” under the heading of “Recent Use of Light in American Art”) and from the inclusion of a single image of his own early work *Atom* (1956) in the first edition. *Beyond Modern Sculpture* thus demonstrates the coterminous character of Burnham’s artistic and intellectual work in the early part of his career. After his CAVS fellowship, and in light of his own recognition of the limitations of his practice, as well as in response to criticisms levelled at the book that came in from 1968 onward in which it was derogated as both technocratic and teleological, Burnham subsequently broke with what he considered to be the romanticization of technology marking the New Bauhausian project as well as with teleological conceptions of advanced art while nonetheless retaining his commitment to systems thinking.

## Systems Aesthetics: A Postformalist Theory of Art

After ceasing to make art of his own, Burnham made a concerted attempt to theorize what he took to be successful *contemporary* art in terms of what he called a “systems aesthetics”, articulating his ideas across a series of “systems” essays. The best-known of these essays today is the eponymous “Systems Esthetics” (1968) but they also included “Sculpture, Systems, and Catastrophe” (1966), “Real-Time Systems” (1969), “Systems and Art” (1969) and “The Aesthetics of Intelligent Systems” (1970). Burnham also developed linked considerations in other related essays including “Notes on Art and Information Processing” (1970), “Alice’s Head: Reflections on Conceptual Art” (1970) and “Problems of Criticism, IX: Art and Technology” (1971).

Burnham’s theory of systems aesthetics had often been read as if it was only articulated in “Systems Esthetics”, but his project for a postformalist aesthetics was articulated across all of his systems essays and developed in dialogue with his prior artistic practice as well as his ongoing teaching. In “Sculpture, Systems and Catastrophe”, for example, Burnham narrates his own artistic investment in the notion of systems in a nuanced way (noting that the art object was not simply rendered obsolete by the emergence of a systems aesthetic and critiquing the overly affirmative embrace of computers by certain artists). And in “Systems and Art” Burnham drew on his experience of giving an “Art and Systems” course at Northwestern, noting the frustrations that he had encountered when trying to teach his students to make kinetic art. Here he reflected on the fact that the Bauhaus-derived industrial era pedagogic methods that were then widely used in the United States were not up to the task and announced his conviction that systems thinking was a technique that was more pedagogically suitable given the fact that it could embrace an understanding of the implications of computer technology and its consequences. Burnham acknowledged that systems thinking was tainted by its association with the Military-Industrial Complex (systems analysis was famously employed by the then Defense Secretary Robert McNamara in the prosecution of the Vietnam War) but noted, by way of contrast, its simultaneous contemporaneous application in pacific fields, including conservation and ecology. For Burnham the essential task for contemporary art and art theory lay in defining the aesthetic implications of a technological world and in establishing thereby the effective implementation of the art impulse in an advanced technological society ([Burnham 1969a](#b-9781474207935-024-0000071): 196–7).

In his systems essays Burnham reacted generationally not only against the ideology of the New Bauhaus but also against the influential formalist theory of art that had been developed by the American art critic Clement Greenberg from the 1930s onwards and which became hegemonic in the 1940s and 1950s before being extended in important respects in the 1960s by Greenberg’s disciple, the American critic and historian Michael Fried. Burnham had originally planned to give “Systems Esthetics” a different title—“Towards a Post-Formalist Esthetic”—but was persuaded by Philip Leider, then the editor of *Artforum* magazine, where the essay was to be published (and at that point a strong ally of Fried’s), to amend his title and to cut substantial parts of his opening polemic against formalist aesthetics. Burnham narrated the artistic paradigm shift he sought to describe as entailing a change from art understood as involving the creation of aesthetic *objects* (principally painting and sculpture) to art understood as the creation of aesthetic *systems* (“unobjects”) characterized by the intersubjective, relational dynamic that they established between people and people and the components of their environment, and wherein conceptual focus, rather than material limits, was understood to determine the boundary of the system so-created ([Burnham 1968b](#b-9781474207935-024-0000066): 31).

Here Burnham moved beyond his earlier focus on the study of a single medium in light of his recognition of the postformalist and post-medium-specific development of artistic practice of the period and the proliferation of new media being employed by artists working in the expanded field of art after minimalism. Burnham developed systems aesthetics as a *general* theory of contemporary art noting that it applied to a wide range of tendencies that had been described art critically under terms including earth art, ecological art, body art, video art and conceptualism. Furthermore, Burnham contextualized this change in the ontology of art against the backdrop of a broader socio-historical shift that he described in terms of the movement from an object-oriented to a systems-oriented *culture*. Burnham understood this large-scale cultural change as a technologically determined paradigm shift that was caused by the movement from the first to the second machine age; from the centrality of industrial “hardware” and the production of individual commodities to post-industrial “software” and the design of whole interrelated “ecologies” of commodities. For Burnham, art as a special, but not exceptional, form of commodity thus required contextualization in relation to these broader shifts in production.

While Burnham’s theory of systems aesthetics was technologically determinist in character it was not technocratic as many of his critics of the period, most notably the American critic and historian Rosalind Krauss, claimed. His notion of a systems aesthetic involved more than just an affirmative investment in then current forms of systems thinking (systems theory, cybernetics and information theory). Rather, it was influenced by the critique of *la technique* developed by the French philosopher, sociologist and theologian Jacques Ellul and held an explicitly aesthetic character in the strong philosophical sense of the term, one that derived from Burnham’s adoption and adaptation of the German critical theorist Herbert Marcuse’s neo-Schillerian rethinking of the possible relation between aesthetic and technological rationality ([Burnham 1968a](#b-9781474207935-024-0000063); [Burnham 1969c](#b-9781474207935-024-0000081)). Burnham sought to combine general systems theory and cybernetics (influenced principally by the work of the biologist Ludwig von Bertalanffy and the mathematician Norbert Wiener) and critical theory (principally in Marcusean form) in a post-(New) Bauhausian project, to explain contemporary art that did not shy away from the implications Burnham believed that the dawn of informational technology would hold for art but which also *resisted* a reactionary technocracy. In so doing he continued to pursue the artistic problems he had previously directly worked on in his own practice by the proxy means of his theoretical, critical and historical writing practice.

According to Burnham the shift to a systems-oriented *culture* would eventually transform artistic and technological decision making into a single activity and thus the leading neo-avant-garde artists of the period should anticipate this situation by liquidating their positions as artists, an end Burnham further pursued in his own pedagogical practice where he sought to dissolve the distinctions between art and technology while moving beyond New Bauhausian educational paradigms through his use of systems thinking. This ambition to dissolve the distinction between art and technology (whose productivist genealogy Burnham acknowledged in “Systems Esthetics”) led Burnham to Marcuse’s work. In his short monograph *Art in the Marcusean Analysis* (1969), originally delivered as a lecture, Burnham comments in detail on his own reading of Marcusean critical theory, and from this text we can trace the influence that Marcuse exerted on his work.

*Art in the Marcusean Analysis* consists of an extended exegesis and critical commentary on Marcuse’s thought up to 1968, largely focused on his aesthetics. In contrast to his Frankfurt School contemporary Theodor Adorno, who famously refused utopian speculation, Marcuse proposed an *aestheticization of technique* as a possible socially transformative response to the domination of technological rationality within technocratic society. This is precisely what Burnham took from Marcuse’s work: rejecting Greenberg and Fried’s formalist aesthetics, he attempted to produce a reformulated account of the vanguard art of the late 1960s as a systems aesthetics that he asserted was anti-technocratic in nature. In order to do so Burnham not only drew on Marcusean theory but also attempted to remedy what he considered to be its deficiencies. To this end, he took up Marcuse’s insight about art’s resistance to technological rationality and its possible role in effecting an aestheticization of technique, but turned it into his own stronger and more deterministic claim that art *would* become an important catalyst for remaking industrial society ([Burnham 1969c](#b-9781474207935-024-0000081): 3). In his reading of the philosopher Burnham correctly observed that the emergence of an *artistic technology*, rather than an emphasis on the significance of the contemporary genre of “tech art”, was Marcuse’s focus and locus of hope (ibid.: 7). Yet Burnham objected to the fact that Marcuse’s work—which was marked by a traditionalism in its artistic taste—did not recognize the validity of the new, post-medium-specific art that embodied a systems aesthetic (and employed new, non-traditional artistic media in order to do so), or acknowledge that it would become a direct instrument of social liberation (ibid.: 8).

Burnham’s theory of systems aesthetics thus in significant part sought to develop core aspects of Marcuse’s work by way of an affirmative reading of post-minimalist art. Burnham’s theory proceeds from his conviction that art after minimalism had ceased to function as illusion and ideal appearance and instead subsisted self-consciously in real space and real time and that consequently a *fusion* of artistic and technical reason would become necessary and inevitable. Here, however, Burnham misunderstood and misapplied Marcuse’s speculative, neo-Schillerian claims for the potential *sublation* of technological rationality by aesthetic rationality in a post-revolutionary social situation, and instead mistakenly argued for the possibility of a “*synthesis*” between incompatible aesthetic and technological rationalities under the actually existing conditions marking post-war liberal capitalism in the US-centred world system (one which would not ultimately be overturned by the radical energies of the 1960s counterculture and which culminated in the suppressed global uprisings of 1968). Thus despite his attempt to overcome Marcuse’s artistic traditionalism Burnham ultimately deradicalized, wittingly or not, the philosopher’s political claims and misunderstood his aesthetic ones. Burnham argued for a process of social reform, rather than revolution, and thought this might be achieved by the *fusion* of artistic and technical reason in a technology based on aesthetic values. Nonetheless, in so doing Burnham’s work also engaged an important tradition of affirmative leftist thought about technology, stemming from Karl Marx’s reading of the fragment on the machines in the *Grundrisse* and developed by Marcuse in the United States.

The tensions that marked Burnham’s theory of systems aesthetics were also manifested in the major curatorial project that Burnham undertook at the Jewish Museum in New York in 1970 sponsored by the American Motors Corporation. In “Software—Information Technology: Its New Meaning for Art” Burnham presented advanced art and advanced technology within the same institutional and conceptual frame. The exhibition featured cutting-edge artists and technologists of the period and Burnham insisted in his catalogue essay for his show, entitled “Notes on Art and Information Processing”, that it made none of the usual qualitative distinctions between the artistic and technical subcultures and asserted that the reason for his unconventional curatorial approach stemmed from his conviction that aesthetic insight had to become a part of technological decision making. His curatorial rationale was thus inspired by the same attempted fusion of Marcuse and systems theory that underlay his theory of systems aesthetics. Burnham’s attempt to prevent his theory of systems aesthetics from being conflated with the ideology of the increasingly marginalized genre of tech art was also an undercurrent that informed the show, in part inflamed by a critical debate that he had entered into in *Artforum* in 1969 with the critic Terry Fenton ([Burnham and Fenton 1969](#b-9781474207935-024-0000127)), who had derogated Burnham’s critical position as amounting to little more than a rehash of post-war Constructivism’s misguided technoscientific enthusiasms (i.e. precisely that which Burnham had sought to move beyond with his theorization of postformalist art). Burnham insisted in his catalogue essay that his exhibition was not seeking to advocate for technological art but rather that the burgeoning information technologies characterizing the second machine age were urgently in need of the aesthetic sensitivity traditionally associated with art in the Western tradition.

Burnham, however, struggled to convey the coherence and the validity of his curatorial premise to the art world of his day and the show was beset by numerous technical and financial difficulties as well as tensions between the participating artists and engineers. The exhibition met with considerable controversy, being widely critically panned and accused of complicity with the Military-Industrial Complex. Even allowing for the misunderstandings visited upon Burnham’s curatorial premise a significant problem for his exhibition was its voluntarism: he attempted to agitate for his hoped-for fusion of aesthetic and technological reason by juxtaposing cutting-edge art and bleeding-edge technology, without acknowledging the fundamental challenges that existed to his hopes for the resolution of the contradictions between their competing rationalities under actually existing social conditions and, indeed, within Enlightenment modernity as a historical epoch.

## From Structuralism to a Hermetic Theory of Modern Art

The equivocal reception that greeted Burnham’s historical, critical and curatorial work led him to jettison the materialist philosophical commitments that informed his previous work. His interest in systems thinking in a broad sense continued but he turned to structuralism as a methodology (understood as a theory of language-based systems) in his second book, *The Structure of Art* (1971). This work announced a new phase of his theoretical project, namely an attempt at a unified, general theory of modern art in which art’s underlying, synchronic, structural logic was understood by analogy with myth. In this text Burnham also announced his renunciation of a number of the commitments that had structured his earlier thinking in *Beyond Modern Sculpture* and his systems essays and which he now came to consider, in light of the criticisms his work had received, as themselves forms of contemporary myth (he resumed these earlier theoretical commitments under the headings of: anthropocentrism; functional rationality; messianic technology; and the illusion of historical progress; [Burnham 1971b](#b-9781474207935-024-0000106)).

Burnham’s second book was, however, beset by its project to equate modern Western art with myth given Enlightenment modernity’s antithetical relationship to the mythic (and notwithstanding the widely acknowledged ambiguity that characterizes exactly this disavowal). *The Structure of Art* dropped Burnham’s prior commitment to dialectical thought, and his attempt to think the relationship between modern art and myth lacked the sophistication of this problematic as famously dialectically formulated by Adorno and Horkheimer in the *Dialectic of Enlightenment* (1947, trans. 1972) wherein myth is understood as itself a form of enlightenment and enlightenment understood to revert to forms of mythology. Instead Burnham attempted to demonstrate that the concept of modern art itself constituted a neo-mythic structure. In so doing he failed to address persuasively the foundational tensions that exist between myth and modernity (and modernism) and consequently produced an unconvincing formulation and treatment of the major issues at stake. This was also in significant part a result of his attempt simply to jettison the principle of rationality with which modernity (and artistic modernism) is structurally entangled. In short order—inspired by his work on putatively hermetic aspects of Duchamp’s work that emerge in his chapter on the artist in *The Structure of Art*—Burnham began to supplement the limited methodology and interpretative schema that he mobilized in *The Structure of Art* with categories drawn from Kabbalah and other esoteric sources. Burnham developed this approach in essays such as “Duchamp’s Bride Stripped Bare: The Meaning of the ‘Large Glass’” (1972) and “Voices from the Gate” (1972), both of which were included in *Great Western Salt Works: Essays on the Meaning of Post-Formalist Art*, an anthology featuring articles by Burnham that had been published between 1968 and 1973.

In the introduction to *Great Western Salt Works* Burnham projected a new iteration of his project that involved developing a full-blown hermetic theory of art. This turn to esoteric sources inaugurated the final phase of Burnham’s intellectual project, wherein he set out to produce a hermetic theory of art. In so doing, he produced work that was categorially disqualified from conventional forms of academic validity (given the modern academy’s foundation and structuration in opposition to the very forms of esoteric thought that Burnham embraced as a corrective to the limitations that he perceived in academic art history and theory). Burnham intended to set out this theory via a projected book on Duchamp, whose work he claimed constituted an esoteric key to the logical semiotic structure of *all* forms of art. Despite receiving a Solomon R. Guggenheim Fellowship to do work on the project in the academic year 1973/4 Burnham’s book remained uncompleted and unpublished in his lifetime.

Burnham’s late hermeticism is perhaps best understood as symptomatic; it is a reaction to, and a final attempt to resolve, a fundamental aporia that marked his work, one that he had not been able to resolve by attempting to mythify modern art in *The Structure of Art*, namely the tension between aesthetic and technological rationality in modernity (and thus between modern art and technology). In Burnham’s important late essay “Art and Technology: The Panacea That Failed” (1980) he explicitly qualified his esoteric turn as an attempt at a mystical re-enchantment of the world, one that he had failed to achieve in his earlier Marcuse-inspired project to reconcile aesthetic and technological rationality through a systems aesthetics. In “Art and Technology” Burnham narrates how the fundamental aporia that characterizes his artistic and intellectual work came to be “resolved” by his later-career recognition that art was a set of secret codes that conceal its fusion of spirit and matter. This mystical understanding of art led Burnham to emphasize esoteric interpretation, inspired by a new faith in an ability to re-enchant the world by revealing veiled truths ([Burnham 1980](#b-9781474207935-024-0000118): 214–15).

Burnham thus produced a coherent, if not persuasive, rationale for the evolution of his work. His embrace of irrationalism in his later career should not, therefore, simply be dismissively pathologized (or passed over in quiet embarrassment). While aspects of his later work resonate with the emergence of New Age thinking that was coincident with the burnout of the radical 1960s counterculture, it was not an example of what Michel Foucault describes in *Madness and Civilization* (1961, trans. 1965) as “reason dazzled” (Burnham’s writing on non-mystical topics in articles written after his esoteric turn is lucid). Rather, Burnham’s late work—such as it can be discerned from the essays that he did publish drawing on esoteric sources—was marked by its attempt to reconcile the tensions that had always defined his artistic and theoretical project. Throughout his writing Burnham sought to resist the “disenchantment of the world” effected by modernity as diagnosed by Max Weber via Friedrich Schiller: the hoped-for fusion of art and technology that he expressed in his earlier and still best-known “systems” work was the major exemplar of this broader problematic.

## Conclusion

Burnham’s art-historical and art-theoretical work is not canonical in the traditional sense of the term. It is not characterized by the production of book-length studies that have proved of enduring influence. Burnham long eluded mainstream art-historical acceptance and his major books are no longer in print. Rather his most significant contributions stem from his occasional “systems” essays, and the ongoing value of the systems aesthetics that he elaborated therein stems from his prescient and determined—but ambiguously successful—attempt to develop a postformalist account of the ontology of art as well as the way in which he combined diverse intellectual approaches drawn from across the humanities and the sciences in order to do so.

Burnham was among the first in the US context to attempt a substantive critique of Greenberg and Fried’s then hegemonic formalist position (innovatively mobilizing methodologies taken from systems theory, cybernetics and information theory in order to do so) as well as one of the first to venture a theoretical alternative to it, anticipating the anti-formalism of artistic postmodernism. His pioneering theory of systems aesthetics sought to combine critical theory with systems theory and cognate disciplines including cybernetics and information theory in order to grasp the nature of nascent forms of post-medium- and post-object-specific art in the expanded field of art that opened up in the 1960s after minimalism had negated painting and sculpture.

Burnham’s theory of systems aesthetics did not fully succeed in grounding the ontology of the postformalist art that it purported to specify since his notion of a system was left deliberately open, disqualifying art made in the traditional mediums, as well as the minimalist “specific object”, but specifying the emerging alternative only very loosely. Nor were his syncretic theoretical ambitions fulfilled: he undertook a highly creative project to combine diverse disciplinary strands and methodological approaches drawn from across the humanities and the sciences but did so in ways that were often problematic. The internal contradictions and incompatibilities that beset Burnham’s syncretic theoretical project (contradictions that he himself acknowledged) led him to embrace esoteric thought in his later work, thus disbarring it from conventional academic legitimacy.

Burnham’s “systems aesthetics” might therefore be historicized as a failed attempt to reformulate the New Bauhausian modernist tradition that Burnham was apprenticed in for an age of advanced technology. As a result, Burnham might now look like a transitional figure in the history of ideas. Nonetheless and notwithstanding these issues Burnham’s ambition to think the relational ontology of distributed, post-medium- and post-object-specific art in the expanded field (and its associated commitment to accounting for the relations between art and technology) was prescient and remains relevant. It anticipated conceptualist, performance, installation and new media art and the diverse methodological influences that informed the making of such art. It also anticipated the methodological diversity of the new art history. Furthermore his theoretical work defined “unobject” art by way of a relational ontology thirty years before the French curator Nicolas Bourriaud’s influential but contentious claims about 1990s relational art exhibiting a supposedly unprecedented “relational aesthetic” in his *Relational Aesthetics* (1998, trans. 2002).

Burnham’s theory of systems aesthetics continues to be re-evaluated in light of the waning of the postmodern “anti-aesthetic” and the postmodern theory of a French poststructuralist stripe that informed it. Here renewed attention to issues of aesthetics and critique in the theoretical humanities have sought to interrogate the philosophical heritage of debates in postmodern theory and specifically the philosophical critique of modernity more broadly, not least its Eurocentric and colonialist determinations. As such, and in light of the growing influence of contemporary posthumanist and ecosystemic currents of thought that share Burnham’s commitment to developing a dialogue between the humanities and the sciences, the reassessment of his historical significance looks set to prove durable.

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Roy Ascott (b. 1934, Bath, England) is the pioneering artist, primary theorist and pedagogical innovator of both cybernetic art and telematic art, serving as a bridge between these scientific and artistic domains and playing a key role in their histories since the 1960s. Ascott’s praxis straddles and exceeds modernity and postmodernity, proposing a “syncretic” paradigm that transcends those discourses ([Figure 25.1](#b-9781474207935-025-0000005)), and adding a strong dose of mysticism.

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From F. T. Marinetti, he inherited a disdain for retrograde art, an unabashedly utopian embrace of technology and a mastery of the manifesto form. Like Marshall McLuhan, for Ascott “the medium is the message” and although the content of his work is invariably meaningful, he theorizes that telematic art embodies meaning, conveys a message and invokes expanded forms of consciousness independent of content. From Marcel Duchamp, Ascott derived a commitment to conceptualism, to diagrammatic forms and chance operations, and to a proto-Derridean conviction in the malleability of systems of signification. Indeed, he characterizes telematic art in Derridean terms as “pure electronic *différance*” ([2003](#b-9781474207935-025-0000192): 233) as a “site of interaction and negotiation for meaning” that heralds a “sunrise of uncertainty … a joyous dance of meaning … [an] unfolding tissue woven of a multiplicity of visual codes and cultural imagination [that suggests] a paradigm shift in our world view, a redescription of reality” (ibid.: 235). Along these lines, the reflexive turn of second-order cybernetics, combined with the relativity of radical constructivism, offered the artist insights into the ineluctable contingency of epistemology and ontology. Ascott’s artwork expands the participatory role of the audience well beyond the interpretative limitations of Umberto Eco’s “open text” and Duchamp’s adage that “a work of art is completed by the viewer” by collapsing categorical distinctions between artist, artwork and audience and flattening value-laden hierarchies among diverse systems of knowledge. Similarly, his highly influential theoretical writings join references to theosophy, Navajo sand painting, parapsychology, the *I Ching* and shamanic ayahuasca rituals alongside references to quantum physics, nano-science, artificial intelligence and string theory, affording all elements equal pride of place. Beginning in the 1960s he conceived of his art practice, his theoretical writing and his teaching as integrated parts of a systemic praxis, each feeding back into the other. Cybernetics pervaded all aspects of this work in the 1960s and 1970s. In the 1980s and 1990s, telematics was the driving principle behind his praxis, reaching a culminating point in the creation of an international, practice-led doctoral programme in interactive art in 1994, using computer networking as a platform for a curriculum that combined in-person and telematic educational contexts. In the 2000s and 2010s, Ascott’s work became more concerned with expanding discourses beyond the limits of “wet” biological media (the body) and “dry” digital media (silicon chips) and embraced “moist” media that hybridized the two. Ultimately, however, technological media serve as a support for Ascott’s aesthetic modus operandi: to envision alternative futures in which the fusion of art and technology expand consciousness and deepen connectivity. In this regard, Ascott’s praxis anticipates and exemplifies the key premise of relational aesthetics: to learn “to inhabit the world in a better way” ([Shanken 2016](#b-9781474207935-025-0000287): 477).

## Art as Cybernetic System and Behaviour

Cybernetics has been defined as an interdisciplinary research field that seeks to model and operationalize “control and communication in animals and machines” ([Wiener 1948](#b-9781474207935-025-0000304)), drawing parallels between them as systems of interconnected feedback loops, thereby establishing conceptual foundations for robotics and artificial intelligence research. Telematics refers to the conjunction of computation and communication, as in computer networking, commonly manifested in the World Wide Web. Beginning in 1959 and pre-dating his awareness of cybernetics, Ascott’s “unplugged” *Change Paintings—*transformable relief sculptures—drew viewers into interactive situations in which artist, artwork and audience were deeply imbricated in interconnected feedback loops. Anticipating the sort of telematic exchanges that would become increasingly ubiquitous beginning in the late 1990s, in the mid-1960s [Ascott (2003d)](#b-9781474207935-025-0000174) theorized a global network of artists and scientists sharing information and collaborating together. In 1980, he organized his first telematic art project, *Terminal Consciousness*, which used computer networking as its medium. As indicated by the title of a collection of his essays, *Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness*, Ascott’s praxis is visionary. Shanken ([2003](#b-9781474207935-025-0000154): 3) claims that “Ascott’s prescience results from applying associative reasoning to the serendipitous conjunction, or network, of insights gained from a widely interdisciplinary professional practice.”

In contrast to conventional art, meaning in Ascott’s cybernetic artworks was not encoded by the artist to be subsequently decoded by the viewer; rather, meaning emerged through the creative participation of the audience as it recombined compositional elements in order to explore a multiplicity of emergent formal and semantic potentials. Having already made this aesthetic leap, cybernetics offered Ascott a formal scientific basis to expand his artistic practice, theoretical writing and teaching. Titles of his works, such as *Homage to C. E. Shannon* ([1963](#b-9781474207935-025-0000301)), *Analogue Table: Wiener-Rosenblueth* ([1964](#b-9781474207935-025-0000162)) and *Bigelow* ([1965](#b-9781474207935-025-0000253)) declare his alliance with the mathematicians and scientists whose work contributed to information theory and cybernetics. Art itself, for Ascott, became a cybernetic system consisting of feedback loops that included the artist, the audience and the environment. This dynamic field of interacting processes and behaviours constantly transformed the system as a whole. As he wrote in his 1967 manifesto “Behaviourables and Futuribles”, “When art is a form of behaviour, software predominates over hardware in the creative sphere. Process replaces product in importance, just as system supersedes structure” (quoted in [Shanken 2003](#b-9781474207935-025-0000281): 26). As Shanken notes,

Ascott envisioned the interactive, systematic processes of cybernetic art as interconnected components in the larger system of feedback loops that constitute culture. Culture, in turn, he theorized as one of many nodes in the network of feedback loops that constitute society. In this way, Ascott’s integration of cybernetics into aesthetics proposed that art, culture, and society were interconnected systems of feedback loops.

— (ibid.: 26–7)

More than any other artist, Ascott serves as a vital link between cybernetics and cyberspace. French art historian and curator Frank Popper, who championed Ascott’s cybernetic art in the 1960s, also proclaimed Ascott as “the outstanding artist and theoretician in the field of telematics” ([Popper 1993](#b-9781474207935-025-0000273): 124). Roger Malina, editor of the journal *Leonardo*, identified Ascott’s *La plissure du texte* ([1983](#b-9781474207935-025-0000236)) as an “unsurpassed landmark in the history of telematic art” ([Shanken 2003](#b-9781474207935-025-0000281): 64). In essays such as “Art and Telematics: Toward a Network Consciousness” ([1984](#b-9781474207935-025-0000132)) and “Is There Love in the Telematic Embrace?” ([1990](#b-9781474207935-025-0000138)), Ascott developed an expanded theory of telematic art, and has applied it to all aspects of his praxis. Like his cybernetic artworks, telematic art challenges the traditional relationship between active viewing subjects and passive art objects, by creating interactive, behavioural contexts for aesthetic encounters, which can now, through the medium of computer networking, transpire among numerous remote participants collaboratively operating on virtual objects. Ascott’s expertise extends beyond his own discipline, and has been acknowledged internationally by numerous governmental and institutional organizations for which he has been consulted. Synthesizing recent advances in science and technology with experimental art and ancient systems of knowledge, Ascott’s visionary theory and practice aspire to enhance human consciousness, and to unite minds around the world in a global telematic embrace that is greater than the sum of its parts.

## Roy Ascott’s Personal History

Ascott’s personal history prior to his artistic career offers important insights into his worldview. His birthplace in south-western England was the home of ancient Druids (Stonehenge, Silbury Hill and Glastonbury are nearby) and later a crossroads for the Romans, who built the famed baths for which his home town is named. The hermetic symbolism of the eighteenth-century Georgian architecture of the city and Silbury Hill’s ancient dome-like formation are dominant features of the landscape. These historical and environmental elements inform the mystical and architectonic aspects of his work (Ars Electronica [2014](#b-9781474207935-025-0000125)). Ascott undertook his National Service with a commission in the Fighter Control division of the Royal Air Force. His role was to interpret and identify patterns of potentially hostile flight behaviour over the North Sea, observed from a bird’s-eye point of view, overlooking large plotting tables, fed with data from multiple remote radar sources. The apparatus, sounds and behaviours of this deeply technological environment fascinated and inspired him. As discussed below, Ascott’s military experience informed his early interactive Cut-Outs and Templates in the 1960s and his intentional shift in the 1970s from the conventional vertical plane of art viewership to the horizontal plane of the tabletop, an enduring motif in his work.

## Education and Mentors

In [1955](#b-9781474207935-025-0000253), Ascott’s formal artistic education began under his mentors—artists Victor Pasmore and Richard Hamilton and scholars Lawrence Gowing and Quentin Bell—at King’s College at the University of Durham. Pasmore’s teaching emphasized organic developmental processes as described in biologist D’Arcy Wentworth Thompson’s *On Growth and Form* ([[1917](#b-9781474207935-025-0000301)] [1963](#b-9781474207935-025-0000301)), providing a scientific model for the durational unfolding of art, understood as a morphological process, not just a product. Hamilton, who remade Duchamp’s *Large Glass*, and whose own work included cyborgian human-machine hybrid forms, opened Ascott’s mind to the paradigm shift precipitated by Marcel Duchamp’s conceptualism. Gowing introduced Ascott to philosopher Henri Bergson’s theories of *élan vital* and *durée* applied to the interpretation of Paul Cézanne’s innovative later paintings, which, for Ascott, “exemplified the constant flux that characterizes the durational phenomenon of consciousness” ([Shanken 2001](#b-9781474207935-025-0000279): 42).

Ascott’s understanding of cybernetics was informed by British pioneers of cybernetics, including his friend and mentor Gordon Pask and Ross Ashby ([Lambert 2017](#b-9781474207935-025-0000253): 42, 50). In the 1970s, Ascott became especially interested in the second-order cybernetics theories of Margaret Mead, Gregory Bateson and in particular Heinz von Foerster, who emphasized that we cannot understand the world as a system unless we acknowledge we are part of that system.

## Early Interactive Works and Publications

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Ascott described his series of *Change Paintings*, begun in 1959, as “analogues of ideas—structures that are subject to change and human intervention in the way that ideas themselves are” ([Ascott 2003](#b-9781474207935-025-0000162)b: 98) ([Figure 25.2](#b-9781474207935-025-0000031)).The viewer is invited to explore an infinite number of compositional possibilities by sliding the Plexiglas panels along grooves in the frame to alter the relationships between the ideas symbolically represented in the gestural painted elements. A *Change Painting*’s reconfigurable Plexiglas panels anticipated Ascott’s “art of futuribles”, a predictive structure that imagines other futures through the interaction of the participants with the artwork ([Ascott 2003](#b-9781474207935-025-0000168)c: 165). Such ideas were further developed in the artist’s 1970 essay “The Psibernetic Arch”, which proposed fusing “cybernetics and parapsychology … the west and east sides of the mind, so to speak; technology and telepathy; provision and prevision; cyb and psi” (ibid.: 161). Furthermore, the *Change Paintings* series is informed by Bergson’s *Creative Evolution* ([1911](#b-9781474207935-025-0000233)) and the notion of *durée* that binds any experience to the past, the present and the future within a continuous, though non-linear, process of perpetual shift and becoming. The structure of *Change Paintings* enables a similar experience of transformation in time by inviting the viewers to participate in it by sliding the paintings’ Plexiglas panels horizontally, backwards or forwards. The viewers’ behaviour results in various designs and meanings, thus bringing into play the artwork’s past, present and future possibilities in terms of visual designs and meanings ([Shanken 2003](#b-9781474207935-025-0000281): 21).

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*Untitled Drawing* (1962; [Figure 25.3](#b-9781474207935-025-0000037)) shows “the I *Ching* hexagrams in the upper register, followed by binary notation, scatter-plots, and wave-forms. A ‘calibrator’ in the middle suggests the ability to juxtapose or combine various permutations of these systems of information representation” ([Shanken 2003](#b-9781474207935-025-0000281): 31). Ascott writes that in his paintings he operates on the level of trance, which allows chance behaviour and automatic actions akin to automatic writing to impact the artistic process. He describes his perception of the wooden board that characterizes the surface of his artworks especially from 1959 to the 1970s as “the arena for any kind of force, just as the ouija board seems to elicit information from a deep psychic level of the participants” ([Ascott 2003](#b-9781474207935-025-0000168)c: 166).

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Ascott’s Cut-Outs and Templates, begun in 1965, are based on both cybernetics and divination principles ([Ascott 1968](#b-9781474207935-025-0000127)) informed by artists’ use of aleatory techniques such as those employed by Marcel Duchamp in *Seven Standard Stoppages* ([1917](#b-9781474207935-025-0000301)) and by John Cage in *Music of Changes* (1951). For *Parameter IV* (1967; [Figure 25.4](#b-9781474207935-025-0000043)), Ascott repeatedly cast coins, as in an I Ching ritual, on a sheet of plywood. He traced the patterns they made, then selectively cut the wood in shapes that explored “ideas of *modulation* in terms of wave forms, fretted profiles, vector diagrams, and oscillating edge-rhythms” ([Ascott 2003](#b-9781474207935-025-0000154): 152). Although displayed on a vertical plane, it is notable that these works were created on a horizontal plane, suggesting the same bird’s-eye perspective that the artist held while observing aircraft activity as a radar officer in the RAF.

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This shift of aesthetic perspective from the vertical to horizontal plane underlies the centrality of the table as a motif in Ascott’s praxis. “The table enables us to sit around our universe of discourse and to transact with one another in that universe” ([Ascott 2003](#b-9781474207935-025-0000156)a: 168). It is a designated area for endless negotiations and modes of behaviours, generating a space between us, other people and objects. “The table is then a device for divination, a sounding board for new relationships within the house or the universe, a test-bed for change” (ibid.: 170). Even when a table as a physical object is not available, it is easily replaced by spreading a cloth on any surface to demarcate a zone for table-like exchanges. Among Middle Eastern societies, the standing table is replaced by a horizontal plane covered by a cloth on the floor or on the ground. The table as an altar in religious settings is the symbolic and ritualistic connector of Heaven and Earth.

In *Plastic Transactions* (1971; [Figure 25.5](#b-9781474207935-025-0000049)) and *Syncretic Divination Table* (1978), fork, funnel, knife, platter and other objects taken from the context of the everyday transform into “psychic instruments” (ibid.: 172). The table becomes a “dream table” on which we can rehearse behaviours and invent alternatives. The tabletop represents a cultural and social stance: “The context of art now is set within concepts of behavior, transaction, process, and system. Our worldview is holistic and integrative. Our vision is cybernetic. We are no longer locked into the moment, we resist the partial view” (ibid.). Art, thus, becomes a conduit of change. The tabletop is the new context of art as an open cybernetic system on which change and meaning can be generated only through the intervention and the behaviours of all those involved in the system, namely the artist, the artwork and the viewers as participants.

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As discussed below, the telematic tabletop demonstrates our agency to trigger and affect change in a hyper-connected digital world. For example, Ascott’s *Plastic Transactions* was incorporated in *LPDT2/3*’s Metaverse in Second Life in [2012](#b-9781474207935-025-0000231) ([Figure 25.6](#b-9781474207935-025-0000056)).

## The Groundcourse: Ascott’s Pedagogical Philosophy

The Groundcourse that Ascott instituted at Ealing College of Art in London in 1961, and at Suffolk Ipswich Civic College in 1964, was a foundations laboratory environment for experimentation in identity, behaviour, change and interactivity in art and social systems. Ascott’s pedagogical philosophy, initially shaped by his mentors Pasmore and Hamilton, was informed by cybernetics and by the notion of art as behaviour and system. Further insight was derived from philosopher John Dewey’s theories of learning by doing, as well as psychologist B. F. Skinner’s philosophy of radical behaviourism and behavioural engineering ([Ayiter 2012](#b-9781474207935-025-0000231): 58). At Ealing, Peter Townshend, who formed the band, The Who, was introduced to Gustav Metzger’s theory of “autodestructive art”, which inspired him to destroy guitars on stage. Such migrations of concepts from art to popular culture substantiate Ascott’s claim that “art is … didactic” and that “through culture it informs … and becomes a force for change in society” ([Ascott 2003](#b-9781474207935-025-0000162)b: 98). Similarly, musician, composer and producer Brian Eno, a Groundcourse student at Ipswich, acknowledged the challenging novelty of Ascott’s cybernetic pedagogy, which informed his awareness of the purpose of creativity and art ([Shanken 2003](#b-9781474207935-025-0000281): 37–9, [Ascott 2013](#b-9781474207935-025-0000220):12–13). Ascott’s radical approach to art and education combined the roles of artist, teacher and shaman ([Ascott 2003](#b-9781474207935-025-0000180)e). He cultivated in his students a sense of social and political agency along with an understanding that “we are moving towards a fully cybernated society … where processes of retroaction, instant communication, and automatic flexibility will inform every aspect of our environment” ([Ascott 2003](#b-9781474207935-025-0000174)d: 126).

## Telematics and Technoetics: Publications and Artistic Projects

Ascott’s cybernetic praxis, joining art practice, theoretical writing and pedagogy, established the foundations for his telematic art practice. According to the artist, telematics is “computer-mediated communications networking” involving the interaction of human minds with “artificial systems of intelligence and perception” ([Ascott 1990](#b-9781474207935-025-0000138): 241). Individuals using the networks become an integral part of “a global net” where the world is in perpetual interaction with them as active participants (ibid.). Ascott’s theory of telematic art is intertwined with his theory of “technoetics”, in which technology is “inextricably linked to consciousness and the noetic practice, rather than in a mere convergence of art and technology as the novel practice of new media art” ([Karoussos 2018](#b-9781474207935-025-0000248): 53).

Ascott’s theory of telematic art weaves together a vast range of aesthetic models. The complexly entangled drips and splatters in Jackson Pollock’s action paintings serve as a “powerful metaphor of interconnectedness”, predictive “of the network consciousness emerging with the telematic culture”([Ascott 1990](#b-9781474207935-025-0000138): 242). Ascott interprets Peter Russell’s vision of the “Global Brain” ([Russell 1998](#b-9781474207935-025-0000276)) as an amalgam of fibres and neurons that heralds the “emergence of planetary consciousness” ([Ascott 1990](#b-9781474207935-025-0000138): 242). The “spiritual or transcendent” provenance of telematic culture can be observed if we are able to perceive the communications networks that overlap the earth as a “subtle body” (ibid.). The subtle body is conceived as a web of energy streams that transmits the prana, the universal life force, in and out of the physical body ([Tansley 1984](#b-9781474207935-025-0000298): 23). Citing Fritz-Albert Popp’s theories of biophotonics, Ascott draws parallels between the emission of photons from DNA in living organisms and the flow “of electrons and photons across the body of the planet through telematic networks” ([Ascott 2006](#b-9781474207935-025-0000210): 65). Building on Teilhard de Chardin’s notion of the noosphere as an evolution of human consciousness, Ascott theorizes the “telematic noosphere” as conveying the subtle transactions of communications networks and minds, which pertains to the “psychic envelope” of earth. Ascott contends that beyond a technological exchange of information, telematic art constitutes “the infrastructure for spiritual interchange that could lead to the harmonization and creative development of the whole planet” ([Ascott 1990](#b-9781474207935-025-0000138): 247).

These spiritual and technoetic elements were at the core of Ascott’s early telematic artwork *Ten Wings*, part of Robert Adrian’s *The World in 24 Hours*, at Ars Electronica in 1982. *Ten Wings* activated a global process of divination based on telematic exchanges taking place around the planet. “Ten Wings” is “the name attributed to the oldest exposition of the *Book of Changes*” ([Ascott 2003](#b-9781474207935-025-0000180)e: 183). Each of the ten remote participators performed a series of divinations by casting coins and transmitted the numerical outcome via the ARTBOX network ([Shanken 2003](#b-9781474207935-025-0000281): 64). Ascott utilized their combined outcomes to produce a “Master Question”. The divination process was then repeated, sent back to Ascott, who consulted the *I Ching* to derive a judgement, commentary and an image, which was shared with all participants and the Ars Electronica Center. As Ascott notes, *Ten Wings* was “the first planetary consultation of I-Ching” ([2003e](#b-9781474207935-025-0000180): 183).

Ascott’s *La plissure du texte* (*LPDT*, [1983](#b-9781474207935-025-0000236)) deployed what he theorizes as “distributed authorship” to create a planetary fairy tale told by remote participants at eleven nodes around the world. It was part of the “Electra” exhibition, curated by Frank Popper at Musée d’Art Moderne de Paris, and utilized the Artists’ Electronic Exchange (ARTEX) computer networking platform continuously for twelve days (11–December 23, 1983). The improvised, collective narrative was completely initiated by Ascott, playing the role of magician in Paris, who announced, “Once upon a time … ”. Each node was ascribed an archetypal fairy tale character, for example witch, princess, hero and so on. Because ARTEX was limited to ASCII characters, the work was primarily textual; however, participators were also able to create images. At the “Electra” exhibition, the output was projected by a beamer, creating a public presence for the evolving artwork. At local nodes, the output was generated by line printers on green bar, continuous stationery paper, spooled on line printers ([Figure 25.7](#b-9781474207935-025-0000073)). Due to the different time zones and the flow of free associations that characterizes improvisation, the French artist and media theorist Edmond Couchot compared *LPDT* to the Surrealist game “exquisite corpse” ([Shanken 2003](#b-9781474207935-025-0000281): 66), in which one artist would begin a drawing, and several others would continue it without seeing the contributions of those who preceded them. The process manifested in Ascott’s *LPDT* could therefore not be the result of one mind. This “collaborative process parallels Ascott’s goal of creating a field of consciousness greater than the sum of its parts” (ibid.). Moreover, the title *La plissure du texte* refers to the French semiotician and literary critic Roland Barthes’ essay *Le Plaisir du Text* (1973). Barthes proposes that a text is perpetually weaved jointly by the author and the reader. However, Ascott’s notion of “Plissure” highlights and implies that pleasure (*plaisir*) derives from the text being “pleated together” through joint authorship (ibid.).

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Almost thirty years later Ascott’s groundbreaking *LPDT* was memorialized and reincarnated as *LPDT2* (2010) and *LPDT3* ([2012](#b-9781474207935-025-0000231)), created by Max Moswitzer, Selavy Oh and Elif Ayiter in Second Life. In *LPDT2/3* the human storytellers around the world are replaced by avatars and robotic entities in metaverses. These 3D environments and their habitats, such as “letters avatars” and “shaman avatar” ([Figure 25.6](#b-9781474207935-025-0000056)), are pleating the text which is generated via a text generator that harvests Project Gutenberg’s dialogues and iterations from masterworks of classical literature. The pleating recalls musical sampling, and the non-linear connections between words, sentences and images suggest new stories and meanings ([*LPDT2/3* n.d.](#b-9781474207935-025-0000261)).

As in *Ten Wings*, conceptual content was vitally important for Ascott’s *Aspects of Gaia: Digital Pathways across the Whole Earth* (1989). This Golden Nica award-winning telematic artwork was inspired by James Lovelock’s holistic *Gaia Hypothesis* ([1979](#b-9781474207935-025-0000258)), which conceives of the earth (Gaia) as a living organism, a self-regulating complex system, maintaining the conditions for planetary life ([Figure 25.8](#b-9781474207935-025-0000080)). The project explored the various aspects of life on earth viewed from “spiritual, scientific, cultural, and mythological perspectives” ([Ascott 1990](#b-9781474207935-025-0000138): 244). Invitations to participate were emailed and faxed to artists, scientists, shamans, visionaries, Indigenous artists of the Americas and Australia, and others (ibid.). The installation had two physical components. In the “information bar” on the second level, inside the venue, viewers could relate and add information to and interact in real time with streams of digital images, texts and sounds dispatched from participants around the world. This aspect of the installation modelled a digital noosphere, a telematic consciousness that embraces and harmonizes the earth. Ascott likened the participants to healers who access the meridians of the earth’s nodes and creatively interact with the flow of data to perform “global acupuncture” (ibid.). The ephemerality of the upper level was joined with the highly embodied somatic engagement that participants could experience in an open-air service area beneath the venue. Lying horizontally on a trolley, the viewer travelled along tracks, passing by LED screens that displayed messages about Gaia. According to Ascott, the viewer traversing the tunnel is akin to a newborn emerging from the birth canal of Gaia’s womb. He describes this dark environment as a telematic, neolithic passageway (ibid.: 245), thus denoting the unification of the organic earth, the biosphere, with its telematic layer, the noosphere. In *Aspects of Gaia*, each viewer becomes a participant of both individual and collective processes that engage the body and mind with the whole earth within a matrix of planetary consciousness.

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In 1989 Ascott coined the term “telenoia”, derived from the Greek roots *tele*, far off, and *nous*, mind. In contrast to paranoia, he explains that “Telenoia is networked consciousness, interactive awareness, mind at large (to use Gregory Bateson’s term)” ([Ascott 2003](#b-9781474207935-025-0000186)f: 259). *Telenoia* (1992) was a 24-hour telecommunications project, which involved a concert that took place through telephone lines. At the V2 centre, which commissioned the work in Hertogenbosch, several computers were installed for the purpose of exchanging images, sounds and texts with artists, scientific institutions, and organizations in various international locations. The project was open to the public, which was able to participate from home via modem and fax. *Telenoia* generated telematic art as a collective and collaborative process. It presented art as open-ended and uncertain, critical, spiritual and political ([Ascott 2003](#b-9781474207935-025-0000186)f).

Ascott coined the term “cyberception” to describe “the emergent human faculty of technologically augmented cognition and perception” ([Ascott 2003](#b-9781474207935-025-0000204)i: 376). In his 1994 essay, “The Architecture of Cyberception”, he describes this phenomenon as the evolutionary outcome of “transpersonal technologies of telepresence, global networking, and cyberspace” that enable us to transform and transcend our bodies and minds. It is the product of telepresence that awakens our psychic abilities and our capacity to “be out of body or in mind-to-mind symbiosis with others” ([Ascott 2003](#b-9781474207935-025-0000198)h: 321).

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In 1997, Ascott explored the relationship between psychic space and cyberspace by immersing himself in the Brazilian jungle, spending a week with the Kuikuro Indians and shamans in the Xingu River region of the Mato Grosso ([Figure 25.9](#b-9781474207935-025-0000087)). This experience was followed by his initiation into the ayahuasca ritual of the Santo Daime community in Brazilia ([Ascott 2003](#b-9781474207935-025-0000192)g: 358). In “Weaving the Shamanic Web” ([1998](#b-9781474207935-025-0000192)), Ascott describes the ability of the shaman to enter different realities in a state of altered awareness and engage with entities and avatars of other worlds. Moreover, the shaman “sees the world through different eyes, navigates the world with different bodies” ([Ascott 2003](#b-9781474207935-025-0000192)g: 358). The shaman possesses a “double gaze”, a vision peculiar to an altered state of consciousness that Ascott experienced during ayahuasca rituals. He describes the double gaze as a mode of dual consciousness whereby one is being in two places at once, having a physical body in reality while having another body that is free to roam in a visionary reality. It is a condition in which one’s awareness fluctuates between two types of reality ([Ascott 2003](#b-9781474207935-025-0000192)g: 359). Ascott defines the shaman as “the one who cares for consciousness” (ibid.: 358). Traditionally, shamans operate in the social sphere of communities, serving as intermediaries and messengers that bridge the spirit world with mundane existence. “As an intermediary who connects the art of diverse cultures and peoples with widely ranging forms of interaction, Ascott can truly be considered a messenger shaman” ([Jacques 2018](#b-9781474207935-025-0000241): 5).

In “Technoetic Pathways toward the Spiritual in Art” ([2006](#b-9781474207935-025-0000210)), Ascott sets in motion a distinct trajectory for the spiritual in art in the twenty-first century. Technoetic arts integrate, in a syncretic manner, ancient spiritual knowledge and shamanic traditions with the tools and data of emerging science and technology ([Moore 2018](#b-9781474207935-025-0000268): 119). Ascott acknowledges Wassily Kandinsky, Piet Mondrian, Kazimir Malevich and others who “believed that art could evoke a spiritual experience” ([Ascott 2006](#b-9781474207935-025-0000210): 69). He reflects on the Navajo sand painting that inspired Pollock ([Ascott 1990](#b-9781474207935-025-0000138): 242) and the influence of Pyotr Ouspensky’s theory of the fourth dimension on modern artists ([Ascott 2003](#b-9781474207935-025-0000154); [Henderson 1983](#b-9781474207935-025-0000236)). At Ascott’s retrospective at the Ninth Shanghai Biennale ([2012](#b-9781474207935-025-0000231)–13), his wall-size Blackboard artworks ([Ascott 2003](#b-9781474207935-025-0000162)b: 103) were displayed next to an exhibition of Rudolf Steiner’s blackboard drawings, thus generating subtle associative links with the Theosophical and Anthroposophical spiritual movements that informed Hilma af Klint, Kandinsky, Mondrian and other modern artists, including Ascott ([Introvigne 2015](#b-9781474207935-025-0000239); [Moore 2017](#b-9781474207935-025-0000263): 327–8). Building on this historic and aesthetic lineage he notes, “We are moving towards the spiritual in art in ways in which Kandinsky could hardly have imagined” ([Ascott 1996](#b-9781474207935-025-0000143): 171; [Kandinsky 1946](#b-9781474207935-025-0000246)). In the twenty-first century the new frontiers, as well as metaphors, of art are in the field of nanotechnology, field theory and mixed reality. The exploration of invisible phenomena can now involve nanotechnology. He claims that it is hard to overestimate the significance of the nano field as an interface that “mediates between pure matter and pure consciousness” ([Ascott 2006](#b-9781474207935-025-0000210): 65). The nano plane is where technology and consciousness meet, and to the artists a challenge which is both material and metaphysical. While to a materialist, nanotechnology involves working with the smallest, subatomic structures of matter alone, it’s not that radical “to see that nano is located between the material density of our everyday world and the numinous spaces of subatomic immateriality” (ibid.).

Moreover, research on biophotonics, magnetic fields, morphic resonance, and field theory may support models of consciousness and human identity held by diverse spiritual traditions, such as Afro-Brazilian Umbanda, African Yoruba, Santo Daime and União do Vegetal in Brazil as well as European native, pagan traditions. As Ascott notes, “These archaic traditions implicitly locate the human within a field of consciousness, rather than seeing consciousness as an epiphenomenon of the brain, as western materialist orthodoxies would argue” (ibid.: 66).

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Technoetic arts transpire in a syncretic model of three variable realities: “Vegetal Reality” of psychoactive plant technology dedicated to entheogenic and spiritual reality; “Validated Reality” based on physical life and mechanical Newtonian technology; “Virtual Reality” of interactive and immersive technologies. These three modes of reality co-exist in a syncretic matrix and enrich one another despite their extreme differences ([Figure 25.10](#b-9781474207935-025-0000095)).

The three variable realities as a model are linked to a second model of syncretic art consisting of five main trajectories ([Figure 25.10](#b-9781474207935-025-0000095)):

1. “Cyberspace and telepresence” implies communication in electronic, immaterial, virtual spaces. It enables individuals to be distributed across remote locations, to be both here and there, and in many places at one and the same time ([Ascott 2003](#b-9781474207935-025-0000186)f: 264).
2. “Psychic space and apparitional presence” alludes to the shamanic path and the spiritual domain ([Ascott 2006](#b-9781474207935-025-0000210): 66).
3. “Ecospace and physical presence” concerns our physical environments, both artificial and natural ([Ascott 2018](#b-9781474207935-025-0000226): 148).
4. “Moist media” implies the use of biological media “comprising bits, atoms, neurons and genes in every kind of combination” ([Ascott 2003](#b-9781474207935-025-0000204)i: 363).
5. “Noetic systems” involve human neural networks merging with global artificial networks “to create a new space of consciousness” (ibid.: 379).

These two interrelated models—the model of variable realities and the model of syncretic art—are based on the premise that “cybernetics underlies the technology of art, and syncretism informs its practice. Syncretic thinking breaches boundaries and subverts protocols” ([Ascott 2008](#b-9781474207935-025-0000215): 1). Syncretic rationale puts the artist outside the norm and at the forefront of human development. The two models are strategies that art and artists can adopt through advanced research and articulated speculation, “combining the attributes of cyberception, moistmedia, quantum reality, the nanofield, and issues in the ecological, social and spiritual domains” (ibid.: 2). The role of art and artists is not to prove or illustrate science but to explore consciousness through syncretic interrelations informed by vanguard scientific thought (ibid.).

## Conclusion

Between 2009 and 2022, Ascott’s works have been exhibited in major retrospective exhibitions that demonstrated how the different strands of his work as an artist, theorist and teacher over many years were always intertwined and impacted each other ([Jacques 2018](#b-9781474207935-025-0000241): 6). In 2014, Ascott was the recipient of the inaugural Prix Ars Electronica Golden Nica Award for Visionary Pioneer of New Media Art. Shanken explains that the term “visionary” ascribed to Ascott implies that his theory and practice are focused on the “visual discourse of art” and on “systematic methods for envisioning the future” ([Shanken 2003](#b-9781474207935-025-0000281): 2). Visual art should become visionary, Ascott declares, imagining the critics and viewers becoming seers in the process of their interaction with art ([Ascott 2003](#b-9781474207935-025-0000168)c: 165). Jacques writes that the visionary state of double consciousness that Ascott experienced in ayahuasca rituals in Brazil ([Ascott 2003](#b-9781474207935-025-0000192)g: 359) allows entry to the world that can only be suggested through “indirection, shared participation, and metaphor. This is the realm that visionary thinkers, creative artists, and shamans alike aspire to experience and explore” ([Jacques 2018](#b-9781474207935-025-0000241): 11). Interestingly, as in a cyclic way, Ascott’s visionary work continues to evolve in the Eastern culture that inspired his early works. The studies in Technoetic Arts provided by his studio at the DeTao Masters Academy in Shanghai are set in the philosophical and spiritual context of the Tao, an awareness that we are immersed in the flow of universal energy and that we are one with this flow, with the natural order of the universe. According to Ascott, the linkage between technoetic processes in design, architecture, art and the Tao is immersion. The question of consciousness, conceived of as a field, is central to the understanding of the Tao. Ascott states:

We consider the brain to be an organ of access to that field. We do not think that the brain is muscle and matter that generates consciousness …. We are …. [closely] related to tradition and to Taoist thought …. That there is a field, that we are the field, we are part of that field of consciousness. We don’t create it, we navigate it, and that has consequences for our practice.

— ([Future Learn n.d.](#b-9781474207935-025-0000296)).

The reach of Ascott’s influence is international and transgenerational. His Groundcourse colleagues and students disseminated the notion of technology as creative and of art as a cybernetic system into the British art scene and countercultural happenings of the 1960s and 1970s ([Sloan 2019](#b-9781474207935-025-0000293): 237–8). His technoetic theories have been further developed and distributed by the graduates of the Planetary Collegium ([Ascott 2018](#b-9781474207935-025-0000226):148). Many of his former students are senior faculty, creating and directing new programmes at leading educational and cultural institutions internationally, passing on Ascott’s syncretic aesthetics to subsequent generations of artists and scholars around the world.

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The French philosophers Gilles Deleuze (1925–1995) and Félix Guattari (1930–1992) are the Wright Brothers of new media art theory. There are many reasons why they have come to be recognized as important intellectual figures to artists, which will be enumerated below. But the first thing to know is that they sought to create concepts that corresponded to the artistic practices of painters, filmmakers and writers.

When they emerged on the Parisian post–May 1968 scene, there were many thinkers and artists who saw the poetic, symbolic, metaphorical dimensions of a work of art as of little importance. Deleuze and Guattari were not among them. Deleuze and Guattari’s general approach to aesthetics suggested a possibility of connecting people (both electronically and psychically) to the great chain of being—that which proceeds us and follows us—through a new approach to making and understanding postmodern contemporary art. What had been particular to postmodernism before Deleuze and Guattari was not the creation and inclusion of something *new*, but rather the newly focused concentration on features of the past that were most often previously overlooked.

Some of Deleuze and Guattari’s most notable theoretical ideas that impacted art included *affects*, *assemblages*, *body without organs*, *deterritorializations*, *lines of flight*, *planes of immanence* and (most importantly) the *rhizome*. Such highly creative and erudite theoretical work followed and transformed the wide stream of theoretical art activity that defined much of the art of the twentieth century—work intent on practising different and ever more severe styles of reductionism in a search for imagined art fundamentals (or universals) and media essences. Misguided by a belief in the ever upward progress of scientific technology that was often then conflated into imagined social progress, the long reductive search for essence had stripped away from art and art theory the symbolic and elegiac elements of some of the best art in the history of the Western tradition, which began proving its remarkable significance in the prehistoric cave called Lascaux.

The urge for reducing idealisms had become integral to almost all of mainstream modern art’s emphasis on abstraction, dematerialization and non-representationalism in the interests of a search for some perceived purity. This ideal search for quintessence peaked and sputtered out in the mid-1970s with the climax of the minimalist and conceptualist art movements—something the philosopher and art critic Arthur Danto described in 1986 as the end of art in his book *The End of Art:* *The Philosophical Disenfranchisement of Art*. But with this sputtering out to an end came a low buzzing noise emitted by every kind of electrical appliance, all of them contributing to a dense noise texture that was the dominant acoustic environment. Such a post-industrial humming environment merged with an increasingly available digital connectivity that began in the mid-1990s. Since then, this electronic atmosphere has been augmented further by a broad-spectrum, data-monitoring, info-economic AI environment, with its non-stop background machine-to-machine gigabyte communications, endlessly humming and murmuring away somewhere well under our conscious perception. Stupendous amounts of data flow every second, set in motion with innocuous clicks or taps, as people everywhere download music and movies on iTunes, check their credit card balances, surf for porn, send emails, buy every sort of product and service, post their personal data updates on social media and post art theory papers on online blogs. All this silent humming is both omnipresent and subliminal to most. The same can be said of the deep, long-lasting influence of Deleuze and Guattari on media art history, art theory and art practice, today.

That is why when the French philosopher Michel Foucault wisely declared that eventually this time will be called *Deleuzean* he was spot on. Certainly, Deleuze and Guattari’s philosophical visions reopened the way in Western art theory for the re-production of symbol and subjectivity and density by affirming the artistic fittingness of *non-hierarchical differences*, of *complex variety* and of the indispensable desirability of *dissension* in art.

When the writings of Deleuze and Guattari first dropped into the world, some of their key theoretical concepts encouraged edifying eccentricity in art by combining the focus on the vibrant material world of *passé* art and craft techniques with electronics and a wider vision of awareness that included diverse, radical, private, spiritual, ecstatic and numinous themes made perceivable as art through the generative interpretative skills of individual artists.

Based on reading their small collaborative book *Nomadology: The War Machine* ([1986](#b-9781474207935-026-0000096))—which redefined the relationship between the state and war in terms of nomads threatening the authority of the state—Deleuze and Guattari’s was an aesthetics of perception-politics based on a plethora of resonances which revealed in minute particulars broad spectrums of the extensive social-political-aesthetic dimension. But unwanted, bad, non-artistic, war machine connectivity is likewise pertinent to Deleuze and Guattari’s theories and propositions of connectivity: like black hat hacking and the spread through social media technologies of bot-driven fake news that can tip democratic elections, which now depend on digital connectivity and increased data monitoring; but also corporate sales systems of connectivity that survey and process in real time personal preferences and movements of users via mobile networks.

## Capitalism and Schizophrenia and Collaboration

When Deleuze and Guattari began collaborating together on a two-volume book of theory called *Capitalism and Schizophrenia*—consisting of *Anti-Oedipus* (1972, translated into English in 1977) and *A Thousand Plateaus* (1980, translated into English in 1987)—Deleuze was a reputable, if daring, French philosophy teacher at Vincennes University. In his early book on the German philosopher Friedrich Nietzsche, Deleuze championed creativity over critique and Deleuze considered himself as a type of artist-philosopher. But his studies on Nietzsche, the French philosopher Henri Bergson and Baruch Spinoza, the philosopher who merged mind and matter into one substance, were each instrumental in reactivating discussion around these thinkers, whose contemporary significance had somewhat waned. In *Difference and Repetition*, Deleuze’s magnum opus philosophical treatise, he developed a profound critique of identity and standard representation that still resonates with today’s concerns with identity politics. In it he developed a metaphysics in which the concept of *multiplicity* replaces that of substance, *event* replaces essence, and *virtuality* replaces possibility.

His writing collaborator, Félix Guattari, was a psychotherapist who trained under and was analysed by the psychoanalyst Jacques Lacan in the early 1950s. Guattari became a radical philosopher, a semiologist and political activist militant director of a non-standard experimental psychiatric clinic at La Borde in Cour-Cheverny, a commune in the Loir-et-Cher department in the Centre-Val de Loire region of France. His programme there consisted of a non-hierarchical suspension of the classical analyst-patient pair in favour of much more open contentions and reconciliations occurring within the context of group therapy sessions.

Guattari’s main focus was on the question of *subjectivity* and how to enrich and reinvent it. In philosophic terms, subjectivity is used to denote that the truth of some privileged class of statements depends on the mental state or reactions of the person making the statement. In epistemology (that in philosophy which is concerned with theories of knowledge), subjectivity is knowledge which is restricted to one’s own perceptions. This implies that the qualities experienced by the senses are not something belonging to the physical beings, but are subject to interpretation. In aesthetics, subjectivism is the view that statements about beauty (for example) are not reports of objective qualities inherent in things, but rather cognitive reports of internal feelings and attitudes.

In his book *Chaosmosis: An Ethico-Aesthetic Paradigm* (1992, translated into English in 1995) Guattari proposes an analysis of subjectivity in terms of four aspects: 1) material, energetic and semiotic fluxes; 2) concrete and abstract machinic phyla (a taxonomic category that ranks above class and below kingdom); 3) virtual universes of value; and 4) finite existential territories.

Both men have written about literature and art and art history, and Guattari would later write some art criticism, usually for the Italian art magazine *Flash Art*. In their book *What Is Philosophy?* (1991, translated into English in 1994)—by the way, a very good entry point to gently getting a taste of the high-minded non-linear style of thinking theory Deleuze and Guattari fully establish in *Anti-Oedipus* and *A Thousand Plateaus*—Deleuze and Guattari suggest that art, in fact, began with those animals who carve out territories around them.

The important thing about Deleuze, from a post-conceptual art standpoint, is that Deleuze conceived of philosophy as the *production of concepts*. That is why he also characterized himself as a metaphysician.

But Deleuze also produced straight if startling original studies in the history of philosophy: writing on Spinoza, Nietzsche, Gottfried Wilhelm Leibniz, Immanuel Kant, the Scottish philosopher David Hume, Bergson and Michel Foucault. Deleuze also delved into the arts by focusing on the paintings of Francis Bacon, in his book *Francis Bacon: The Logic of Sensation* (1981, translated into English in 2003) and wrote copiously on film in his two-volume cinema series of books: *Cinema 1: The Movement-Image* (1983, translated into English in 1986) and *Cinema 2: The Movement-Image* (1985, translated into English in 1989). He also published a collection of essays on literature, wrote a book on Marcel Proust, one on the Bohemian novelist and short-story writer Franz Kafka, and one on the Austrian writer Leopold von Sacher-Masoch.

Of the two *Capitalism and Schizophrenia* collaborative books by Deleuze and Guattari, *A Thousand Plateaus* had the biggest impact upon media art, experimental music and painting as they were being reconsidered within the new context of the burgeoning digital revolution: specifically the early 1990s internet culture (aka cyberculture). This is the case because *A Thousand Plateaus* articulated an epistemology based on the intellectual model of the *rhizome*.

For one, their *rhizomatic theory* encouraged artistic non-linear and non-restrictive interdisciplinary creative thinking and doing. That is why Deleuze and Guattari’s art aesthetics has become so embedded in the recognition of arts’ sheer potentiality to expand and inform. Rhizomatic theory points out that what we have in common is a dangerous propensity for overrating our powers of comprehension.

Deleuze and Guattari’s rhizomatic aesthetics is hostile to generalizations. It is recalcitrant by design. It affirms with jubilation our state of varied mutability. Indeed, I believe that some form of rhizomatic thinking is a necessity for originality to emerge today, and the recognition of the necessity of Deleuze and Guattari’s rhizomatic aesthetics is part of the peculiar pleasure that current art affords. A pleasure clearly of rapturous abandonment, where the intended effect is liberation by means of de-simulation. Their rhizomatic aesthetics opens up in us a sense of possibility that we understand and feel at one and the same time to be both dangerous and indispensable.

## Rhizomatic Theory

A biological rhizome, literally, is a root-like plant stem that forms a large entwined spherical zone of small roots which criss-cross. In the theoretical writings of Deleuze and Guattari—especially in *A Thousand Plateaus* but also including their key small book *What Is Philosophy?*—the term “rhizome” is used as a metaphor for an epistemology that spreads in all directions simultaneously. This non-hierarchical and theoretically unlimited connectivity (which they also articulated as concept-acts of *becoming*) not only corresponds to the theoretical global functionality of internet connectivity, but also corresponded to the vivid imagination of inspired-by-technology artists in the 1990s (including the author).

For example, the 1993 Ars Electronica and Golden Nica award-winning artists’ group Knowbotic Research KR+cF used the term “non-locations” for their use of disjointed spatial experiences within their art: a term inspired by the concept of what is called *deterritorializations* in the theories of Deleuze and Guattari. Knowbotic Research KR+cF distinguished such non-locations as aggregates of multilayered occurrences in physical and electronic space which are non-homogeneous, fragmented and incomplete; while being at the same time continuous, hermetic and flowing.

Also relational art (and relational aesthetics), a late-1990s tendency in fine art practice originally observed and highlighted by French art critic Nicolas Bourriaud, took some of its ideas from the work of Deleuze and Guattari. Bourriaud defined the relational approach to art simply as a set of artistic practices which take as their theoretical and practical point of departure the whole of human relations and their social context, rather than an independent and private space. The artist can be more accurately viewed as the catalyst in relational art, rather than being above or at the centre of things, as art curators usually are.

Such artistic ideals were based on portions of Deleuze and Guattari’s rhizomatic model, in that a rhizome is a rich spherical labyrinthine ensemble of relations, diversities, connections, heterogeneities, breaks and unexpected links which—nonetheless—interconnect as a composite unity. Underlying this aim is a chimeric idea which questions linear and hierarchical structures and seeks to replace them with atmospheric loose structures keyed to a penetrable, reciprocal flow of events.

In *A Thousand Plateaus* Deleuze and Guattari had further defined the rhizome as that which is reducible to neither one nor the multiple. It has neither a beginning nor an end, but always a *milieu* (middle) from which it grows and which it overspills. As such, it constitutes linear multiplicities with *n* dimensions, having neither subject nor object.

## Internet I Hyperactivity

During 1980s postmodernism, modernism’s previous formal examinations of the artwork were largely set aside in favour of investigations into art’s social and ideological determinants, be they explicit or implicit. Postmodern art thus aspired to employ the affective capability of easily recognizable popular images.

As Deleuze and Guattari became interested and immersed in the competitive schizo-capitalist global media landscape of late twentieth century—which expedited real warring conflicts or peaceful accords—questions of representational rapport became of utmost importance to them. Salient to their concerns was the United States Department of Defense’s Advanced Research Projects Agency (ARPA) and its initial founding of the Advanced Research Projects Agency Network (ARPANET): an early packet-switching network and the first network to implement the TCP/IP protocol suite. Both technologies became the technical foundation of the internet when ARPANET was decommissioned in 1990. As such, *A Thousand Plateaus* was prescient, as the space of the mid-1990s internet could not be thought of as a coherent totality other than as a hyper rhizome; for the internet is a very numerous collection of hyper-linked files. Similarly, *A Thousand Plateaus* was designed to be able to be read in hyper non-linear, subjective fashion. The book itself is somewhat non-linear in form and intent, and certainly can be used that way.

In that I am evoking the word “hyper” here, and the phrase hyper-linked, I shall briefly summarize the basis of the hyper concept as adapted from the procedures of hyper-text, hyper-media and hyper-reality, for the reader. The structural strategy of hyper-anything includes principles of networked connections and electronic links which give multiple choices of passages to follow and continually new branching possibilities. Following this understanding, the Deleuze-Guattarian theoretical model for art then emphasizes self-re-programmability. The style of art privileged here explicitly or implicitly offers a furtherance in envisioning and enacting anti-hierarchical models and modes for perception.

Postmodernism had opened the door to a plethora of once marginalized heterogeneous genres. Within Deleuze-Guattarian rhizome theory, spatial relationships implode into noisy chaotic grounds to the extent that normal figure–ground relationships more or less merge, playing elusively with what is suggested, what is repressed and what is desired. This meant shifts into non-binary visual noise fields where viewers can reappropriate their capacity of divination. They can more freely visualize content on a subjective basis.

For Deleuze and Guattari, rhizomatic art was a generative and virulent and curative unleashing of subjective forces of reverberation that resonate like a web of interconnected, molecular and viral-relational affects and intensities. As such, according to their ideas political art is something that participates in vibrant dissonance, deviation and the conspiratorial.

In understanding their rhizomatic theory, remember that Deleuze and Guattari’s view of aesthetics involves the communication of enigma itself. That means they invite each and every subject to want more from the art object experience. They invite subjectivity to look deeper than the picture plane or pop image on a screen. Deleuze and Guattari’s approach to art involves looking *into* and projecting *onto* the art object. And in some way interacting with it, as opposed to only looking *at* something. In that sense, their idea of rhizomatic art requires the engagement of active subjectivity and (though perhaps slow) participation on the part of the audience-participant. This corresponds perfectly with what Marcel Duchamp said in 1957 at the Convention of the American Federation of Arts in Houston, Texas: that the creative act is not performed by the artist alone. Spectators bring the artwork in contact with the external world by deciphering and interpreting its inner qualifications and thus add on their subjective contribution to the creative act.

The act of reading Deleuze and Guattari demands as much. Involving oneself with their rhizomatic theoretical propositions requires the use of the willing readers’ mental creative participation. Fortunately, this is something essential for creating originality within our global climate of shared mass media. The rhizomatic tenants of Deleuze and Guattari’s excess cut against the grain of fast, objective, consensus visibility to art’s great benefit. After Deleuze and Guattari, the worth of contemporary art is in its ability to deliver vigorous and unexpected sensually embodied implications.

To produce such implications, their labyrinthine aesthetic contains systems of chance operations within its rhizome. That allowed their philosophical vision to lead the way towards socially symbolic, semi-abstract, palimpsest-like works of art that are full of subjective subliminal excess. This plethora is valuable in that such maximalist rhizomatic art offers society a greater freedom of aesthetic choice (along with greater uncertainty) due to the presentation of excessive amounts of aesthetic material and information via rhizomatic ground/figure collapse.

To further clarify, Deleuze and Guattari’s art theory utilized principles of aesthetic rhizomatic noise that put representation and abstraction into interactive play by flipping the common figure/ground emphasis to some extent. This entails intimate acts of seeing and imaging on the part of the reader-viewer that enable a critique of “representation” in the aesthetic sense to become part of a critique of “representation” in the political sense (and vice versa). As such, Deleuze and Guattari mark a qualitative transformation into the connected non-place of the web, where being and non-being may reverse into each other, unfolding out, and enfolding in, their respective fluxes.

Their rhizomatic methodology encouraged just such interdisciplinary crossings where technology’s, art’s and philosophy’s previously insular roles (which tried to examine their areas as unique, sealed-off disciplines) are cross-blended. Certainly Deleuze and Guattari’s rhizomatic theory articulated (in pre-hyperlink non-linear fashion) the possibility of conceiving and actualizing artworks composed of variously formed segments, strata and lines of flight; which involve territorializing as well as de-territorializing objects, medium and themes. This rhizomatic understanding of interconnectivity was and remains a particularly important point of consideration for media art theory, as intermedia, a term used in the mid-1960s by fluxus artist Dick Higgins, took on the characteristics of a universalizing digital medium in the early twenty-first century.

Already in 1980, Deleuze and Guattari had asserted that what is real in art (and in the world at large) are blocks of becoming, not the supposedly fixed terms through which things are categorized. This is almost a perfect proclamation of the need of free expressive creativity. What is important for artists of all kinds is that the rhizome can be connected with any other point, even while rhizomes remain heterogeneous. According to Deleuze and Guattari, rhizomatic creative activity is boundless in its branching; thus artistic reflections and expressions may cross wide chasms of physical, psychological, thematic and perceptual spaces as disparate elements and details may be linked together. Just as images and texts and sounds are within the internet. Moreover, a rhizomatic-based art influenced by Deleuze and Guattari is dynamic, and is ceaselessly actualized by the arousal its dynamism produces. Thus rhizomatic-based art is not in accord with some pre-established strategy or imposed configuration.

The rhizome is regularly swarming itself into being as micro and macro factors attract and snap. One cannot declare in advance what its limiting confines are, or where it will (or will not) operate, nor what may become connected and tangled up in the rhizome’s multiple dimensions, because the connections do not inevitably plait common types together. Rather a rhizome’s multiple dimensions instigate crossovers between both the highest synthetic level and the slightest, most minute discrete distinctions. Indeed, rhizomatic art is a complication of perceptual vicissitudes so intertwined that it can give birth to different scopes of phenomenological macro-perception.

## Virtual Bwo

This rhizomatic idea for art, which was articulated before the fact of the communal internet by Deleuze and Guattari, greatly aided in redefining the arts in general as they were being reshaped in the mid-1990s by the arrival of virtual making tools of digitalization. Another example of Deleuze’s prescient talents is that—writing way before his collaborations with Guattari—Deleuze established a fundamental concept of our time, with his philosophical explanation of the *virtual*. True to form, Deleuze did so creatively, via the work of Marcel Proust, best known for his monumental novel *À la recherche du temps perdu* (In Search of Lost Time; previously known as *Remembrance of Things Past*), originally published in seven parts between 1913 and 1927. Deleuze first did so in his 1966 book on the previously mentioned French philosopher of flux, Henri Bergson, in Deleuze’s book *Bergsonism* (1966, translated into English in 1988). Bergson was the first modern theorist to elaborate what came to be called process philosophy, which rejects static values in favour of values of motion, change and evolution. In *Bergsonism*, Deleuze identifies three pivotal Bergsonian concepts—duration, memory and *élan vital*—and shows the relevance of Bergson’s ideas to contemporary philosophical debates. Also in *Bergsonism*, Deleuze defined the virtual, via the work of Proust, as *that which is real without being actual* and *ideal without being abstract*.

Following Deleuze here, Pierre Lévy in his 1998 book *Becoming Virtual: Reality in the Digital Age* defined virtuality as a complex of trends, tendencies, constraints, goals and forces linked to a creative problem solving process. Lévy also established that the emergence of cyberspace made more pressing certain questions that artists have been posing since Marcel Duchamp’s *La mariée mise à nu par ses célibataires, même* (1915–23, The Bride Stripped Bare by Her Bachelors, Even) by virtualizing the work of art. Thereby questioning the conventions of its creation, exhibition, reception, reproduction, distribution, interpretation, and the different forms of distinction brought about by “the work”.

Brian Massumi, the English-language translator of *A Thousand Plateaus* and author of *A User’s Guide to Capitalism and Schizophrenia: Deviations from Deleuze and Guattari*, was in conspicuous agreement with Lévy. Massumi defined the virtual as those intense tendencies which produce a realm of *potentiality*. But for Massumi, the virtual is also a lived paradox where what are normally opposites coexist, coalesce and connect.

In *A Thousand Plateaus*, Deleuze and Guattari described this free-flowing shift into the potentiality of boundlessness as becoming a *body without organs* (BwO): that is, where self-shifting representational planes emerge out of our field of compositional consistency. For the body without organs, according to Deleuze and Guattari—via their interpretation of the wild writings of Antonin Artaud, the French dramatist, poet, essayist, actor and theatre director—is an insubstantial state of connected being beyond representation which concerns *becomings*. Deleuze and Guattari maintain, in a rather surrealistic fashion, that all molecular becomings begin with, and pass through, becoming-woman. Becoming-woman is the key to all the other becomings, such as becoming-animal and becoming-imperceptible. The imperceptible is the immanent end of becoming: its cosmic direction.

Deleuze and Guattari go on to say in *A Thousand Plateaus* that the body without organs causes intensities to pass; and that it produces and distributes them in a spatium that is itself intensive, lacking extension. The body without organs is not space nor is it in space; it is matter that occupies space to a given degree (to the degree corresponding to the intensities produced).

According to Massumi, the body without organs is an endless weaving together of singular states, each of which is an integration of one or more impulses. These impulses form the body’s various erogenous zones of condensed vibratory regions; zones of intensity in suspended animation. Hence the body without organs is the body outside any determinate state, poised for any action in its repertory. This is the body in terms of its potential (or virtuality) within post-industrial society. This dynamic state is typical of that art which has come to be known as *post-conceptual* but can also be tied to décadent French theory, which was almost the equivalent of the fin-de-siècle symbolist theory that aspired to set art free from the materialistic preoccupations of industrial society.

Symbolist theory was formed primarily by the French poets Jean Moréas and Stéphane Mallarmé influenced by Charles Baudelaire’s *Les fleurs du mal* (The Flowers of Evil) and is concerned with the theme of escape from reality. But while Baudelaire’s escapism had been of an essentially emotional and sensual kind, Mallarmé’s was of a much more intellectual bent, and his determination to analyse the nature of the ideal world and its relationship with reality is reflected in the two dramatic poems he began to write in 1864 and 1865, respectively, *Hérodiade* (Herodias) and *L’Après-midi d’un faune* (The Afternoon of a Faun). In 1886 Moréas published a declaration which outlined the theory called *Le symbolisme* (Symbolist Manifesto), thus giving the outlook its explicit name.

## Deleuze-Guattarian Viractual Post-Conceptual Art

Art functions by the felt transmission of ideals which act in exciting other people’s feelings, ideals and creativity. Reading Deleuze and Guattari is a discovery that a good deal of the basis for the questioning of the Western artistic tradition can be found in the Western tradition itself if we look with new eyes and ask new questions joined with an interest in non-Western expressions which may offer divergent perspectives on the West’s previously totalizing self-image. Instead of stressing the reflective limits imposed by the category of Western art, Deleuze-Guattarian aesthetics attempts to specify resistances embodied within it. Their style of global aesthetics urges the mind towards transformations. Here art theory depends on using the infinite space of the world tied to artistic hyper-chaotic imagination.

Deleuze-Guattarian post-conceptual art is that contemporary art that builds upon the legacy of Duchamp and conceptual art: where the concept(s) or idea(s) involved in the work take precedence over traditional aesthetic and material concerns. Post-conceptual art has been traced to the work of Robert Smithson and the intermedia concept employed by Dick Higgins, but is now more often connected to digital art production where the computer code sets the conceptual rules for a physical production. In my book *Immersion into Noise* I have identified this post-convergent and post-conceptual trend in 1999 as: *viractuality*.

British philosopher and theorist of conceptual Art Peter Osborne makes the point that post-conceptual art is not the name for a particular type of art so much as the historical-ontological condition for the production of Deleuze-Guattarian type contemporary art in general. With the increased augmentation of the self via networked electronics, the virtual now coexists with the actual (thus my term *viractual*) as the digital links up with the organic. Consequently, the Deleuze-Guattarian post-conceptual art object demonstrates an interlaced sense of artistic viractuality that couples the organic with the technological and the static with the malleable. The post-conceptual art aspect of viractualism is essentially a Deleuze-Guattarian prosthetic for the meeting up of the machinic and the corporal dominions.

Essentially, the foundation of Deleuze-Guattarian viractual post-conceptual art is that computer technology has become a significant means to making and understanding contemporary art. Consequently, with Deleuze-Guattarian post-conceptual art, artists are investigating art in its many connected forms by addressing the merging of the computed (the virtual) with the un-computed corporeal (the actual). This merging in Deleuze-Guattarian post-conceptual art begins with the realization that technology disrupts previous rhythms of art and consciousness in light of the data-driven information age.

The Deleuze-Guattarian post-conceptual art object can be further inscribed as a thing of viractual liminality which—according to the anthropologist Arnold van Gennep, based on his anthropological studies of social rites of passage (1960)—is the condition of being on a threshold between spaces. A key Deleuze-Guattarian conceptual context for media and art is that virtual-producing computer technology has become a significant means for the blending of computation with the art object. This merger indicates a subsequent emergence of a new topological cognitive vision of links between the computed virtual and the sensual corporeal world.

The Deleuze-Guattarian post-conceptual art object recognizes and uses the power of digitization while being culturally aware of the values of bodily (physical) connections to monumentality and permanency—qualities that can be found in some powerful analogue art throughout the world and the ages. This indicates and initiates communions of the protoplasmic body to virtual spatial conditions. Consequently, the Deleuze-Guattarian post-conceptual aspect of art articulates a digital-physical sense of culture. Yet remember that Deleuze and Guattari rejected, particularly in the realm of art, the *post hoc ergo propter hoc* (after this, therefore because of this) logical error of assumed causality.

But clearly after Deleuze and Guattari developed and published their complex theory of neuro-philosophical hyper-totality for art, it became the dominant spirit of the end of the millennium. A new and fuller posthumanist understanding of art and technology and life emerged that redefined postmodernism’s emphasis, which had been merely deconstructive of totalities. One of Deleuze and Guattari’s terms for this spirit is *becoming-animal*. For Deleuze and Guattari, for art to become animal is to participate in movement that stakes out paths of escape and crosses established thresholds to reach a connected continuum of intensities where all forms come undone by self-fashioning an artistic map of intensities. Becoming-animal in art means undoing all significations, signifiers and signifieds in favour of abstract unformed matter where de-territorialized flux and the non-signifying of signs may occur. But it must be grasped that Deleuze and Guattari’s vision is not just that of disorder, but that it also may produce order and stability, even little static worlds, as well as the complete destruction of what is.

Within Deleuze and Guattari’s becoming-animal theory, art emphasizes human and non-human entanglements. Theirs is an art idea that depends on playing out nihilistic negativity by intensifying its forces into an affirmative nihilism that pushes art towards open de-familiarizations, challenging the artist to think outside of the normal system of human consciousness. Their art theory implicates the very type of problematic instability that the self undergoes in Nietzsche’s thought: the cohesiveness of the culture/state distinction—like the cohesiveness of the self/other distinction—disintegrates with the ontological instability produced in such discursive fashion.

But the art and art theory influenced by Deleuze and Guattari was not, and certainly is not, a homogeneous practice, but a complex field converging around perceived weaknesses in the history of art theory concerning purity. For example, Mille Plateaux, the German record label founded in 1993 by Achim Szepanski and named after *A Thousand Plateaus: Capitalism and Schizophrenia*, published a wide range of audio styles, including experimental electronic music, minimal techno, and glitch noise music. But Deleuze and Guattari’s hyper-cognitive impact usually happened (and happens) when the particulars of electronic connectivity are seen as part of an accrual total system by virtue of its being connected to everything else while remaining dissonant.

In like fashion, Deleuze and Guattari also stimulated activist left-political art by placing emphasis on the production of individual subjectivity connected to a political physiology (a function of living systems) through their strong support of emerging liberation movements. Deleuze and Guattari’s theory of political leftist art as rhizomatic in form, is also one of resistance in that it is based in scepticism towards simplicity, and undermines market predictabilities, by strengthening personal powers of imagination and critical thinking. In general, their political theory counters the effects of our age of simplification. Effects which have resulted from the glut of consumer-oriented politainment messages which mass media distributes to benefit corporate and governmental psychological manipulations.

Reading and thinking about the theories of Deleuze and Guattari when they first were published—as now—articulates for politically motivated artists the fact that embedded in our inner self is the non-linear life of the imagination, ripe with its intense drives, suspicions, fears, hates and loves. Deleuze and Guattari guide those inner-driven artistic and emotional intentions and actions into the wider political-economic world. But they still recognized that an artist’s inner world is the only true source of meaning and purpose available for the production of originality in the field of fine art-as-politics.

The Deleuze and Guattari style of nimble gazing and grazing is one way for art students to discover the merging of art and politics as an intense inner life. They ask the young artist (in contrast to our frenzied political data surveillance culture—that exteriority of which also steers young artists to fear the outer perception of the critic and yield to art market familiarity) to consider working with personal, agile, clandestine exchanges based on their own intuitive mind and imagination in conjunctive contact with social-political and art-historical abundance.

## A Phantasmagorical Avant-Garde Legacy

The radical and spectacular concepts of Deleuze and Guattari have by now passed through the experimental phase. We all know about the downside of connectivity: art spilling over into entertainment and the dangers of disinformation and surveillance that monitors psycho-data. So it must be stressed that Deleuze and Guattari themselves offered much better ideas that all pointed towards a possible shared future based in the cooperative common ground of sociality. Their ideal was a shared and common human-animal-mineral ground that precedes and surpasses narrow national populist communities. Their central proposition was the creation, partially through art, philosophy and literature, of a commons of contact. Understanding and exchange are to be built politically through the creation of innovative individual-polis assemblages and new modes of organization of the individual-collective from which all benefit. In *Capitalism and Schizophrenia*, Deleuze and Guattari made this clear as the purpose of connected culture.

But remember this: what is important in reading Deleuze and Guattari as art theory is the intentional enigma encountered in *Capitalism and Schizophrenia*. Their radical collective ideas presented here needed to be obscure to the degree that tired old established concepts and institutions (such as the state) could not be easily differentiated out of larger collectives, and thus maintained as cultural truths.

The deep dive into phantasmagorical obscurity and complex mystery encountered when first reading Deleuze and Guattari, I must say, is more and more desirable in a world that has become increasingly data-mined, mapped, quantified, specialized, controlled and identified in a straightforward matter-of-fact way. For those artists that have absorbed their philosophy, the paucity of pop art, read at a fast glance, conceals the riches of associational gazing with respect to Deleuze and Guattari’s combinatory dynamics and emphasis on networked and layered creations.

I believe that it is now correct to say that Deleuze and Guattari’s principle of constructing patterns of infinite becomings was always inherent in the avant-garde artistic tradition. What might be thought of as avant-garde values. Deleuze and Guattari encouraged the making of art as a style of anti-purist rejections of the tyranny of labels, essential identities, privileged abstractions and fixed ideas. The phantasmagorical aesthetic enigmas they spun are alluring when intelligible, standard art history is perceived as overly narrow, hollow, trite or insensitive to the diversity of humanity and the intensity of technology. Their goal was to disrupt instrumental art logic and contradict, counteract and cancel hollow cultural feelings. As such, they indirectly encourage artists to imagine art as something constructed from the unstable distinctions between subjects and objects. Theirs is an idea of art that embraces the entire spectrum of imaginary spaces: from the infinitude of actual forms to formless voids of virtuality. Subsequently, Deleuze and Guattari challenge the hierarchy of figure and ground, and representation and abstraction, through struggles with rhizomatic fields of signal/noise.

Certainly the globalized-internet is much about connecting the world, so the aesthetics of Deleuze and Guattari should also be thought of in terms of spatialization: dimensions, areas and territories. What space does rhizomatic art clear and what space does it fill? How can the rhizomatic aesthetic of Deleuze and Guattari help us think and live differently within our smooth surveyed spaces? How can we live more intently and intensely in their rhizomatic vision of the cosmos rooted in non-closure, with its yearning for otherness in the non-appropriative mode?

## Conclusion

Certainly the changing values of the avant-garde have always been interfering with the well-monied channels of artistic production and reception; and these avant-garde values are responsible for expanding the forms and definitions of art itself. This Marcel Duchamp has definitively demonstrated. Deleuze and Guattari assert that this Duchampian expansion can always be ensured by not ignoring the differences between the personal and the political. On the contrary, their rhizomatic theory encourages realizing and demonstrating how differences resonate together in unpredictable and contingent ways to form—in the words of Gilles Deleuze—*planes of consistency* from which new political-artistic concepts can be formed. But such planes can no longer be a form of *enfant terrible* withdrawal, akin to Duchamp’s strategic invisibility. Duchamp’s entire artistic activity had been—since the definitive incompletion of his masterpiece *The Bride Stripped Bare by Her Bachelors, Even* in 1923—an exercise in strategic invisibility, giving rise to objects and events which—because they were apparently too impermanent or unimportant or insubstantial, or because they eluded established genre conventions, or because they confused or diluted authorial identity—evaded recognition as works of art. Rather, Deleuze and Guattari purported a phantasmagorical plunge into what Félix Guattari called the *chaosmosis* (in his book *Chaosmosis*) where he maintained that the work of art, *for those who use it*, is an activity of *rupturing* *proliferation* or *extreme impoverishment* that leads to a recreation and reinvention of the subject itself.

What disturbs some people when first reading Deleuze and Guattari, but feeds the imagination of artists of all kinds, is that reading them is somewhat a plunge into a maelstrom of chaos and exaltation. Deleuze and Guattari’s non-linear writing/thinking style functions as a way of seeing and thinking that reverses the order of figure/ground to ground/figure, collapsing being into a shared state of non-being. That means ontological implosion. As such, their rhizomatic thinking-method creates for artists an appreciation of ambivalent aleatory (chance) processes that can be truer to the powers of free imagination; exploding with brews of dynamic expansion, transformation and disintegration.

In dealing with their radical style of addressing subjectivity, feelings of collapse-extension-connection are encountered. That is what connects Deleuze and Guattari’s theory to contemporary complexity theory and to some aspects of AI. These moments of collapse-extension-connection in Deleuze and Guattari also accompany the contemporary art development where the static image has become dynamically engaged with the human imagination and personal choices of the viewer. In some cases literally, engaging the participation of the viewer to the point of physical interactivity. In other cases they are engaged post-conceptually, by long relaxed looking.

Such forms of aesthetic post-conceptual participation can be a decisive element in offering generative possibilities of development that continue to be interesting and supportive of the creation of originality in art. A post-conceptual generative art (or semi-generative art) is perhaps the most evident example of Deleuze and Guattari’s aesthetic concerns, in that generative and semi-generative art serves to produce unpredictable results, both when it is based on arithmetic instructions contained in code, or in other ritual-like rules in which the artist establishes the operational tenets or choices that are calculated to act autonomously or semi-autonomously.

The elaboration of Deleuze and Guattari’s generative and degenerative aesthetics was (and is) a move away from the search for purity in art and is a return to the shifting ground on which art experimentalism rests. As such, their hyperactive ideas gave back to art a sense of secret discovery that marked art’s beginning in Lascaux as an alternative and phantasmagorical way to express the agitation between form and the ground.

That said, it must not be forgotten that Deleuze-Guattarian aesthetics of generative and degenerative subjectivity suggests (and can produce) stress in the audience, as well as in the artist. One might even feel, at times, an exigent anxiety of ego disintegration. So dedication to its merits might well be described as vaguely heroic, because their phantasmagorical networked art aesthetics can be as creative as it can be destructive. Indeed, it implies an endless struggle between the two. In that sense, their art theory contains within itself a cul-de-sac of ill communication, which Deleuze, late in his life, called a *vacuole*.

This vacuole concept of phantasmagorical disconnection and non-communication comes from Deleuze’s 1992 essay “Postscript on the Societies of Control” where he (very early on) established the notion that control is just as connected to information-communication technology as is liberating freedom. This useful vacuole conception Deleuze extracted out of the work of William S. Burroughs, the American Beat Generation writer and visual artist.

The vacuole is a major part of the plant and animal cell. In biology, a vacuole is like a sac in a cell’s membrane, completely bound up inside the cell, but also separate from it. Vacuoles play a significant role in autophagy, maintaining a balance between biogenesis (production) and degradation (or turnover) of many substances and cell structures.

Félix Guattari died suddenly, on August 29, 1992, in La Borde from a heart attack, at only sixty-two years of age. Gilles Deleuze had suffered from a debilitating pulmonary ailment throughout the last twenty-five years of his life and in his last decade this condition grew more severe. On November 4, 1995, at seventy years of age, Deleuze took his own life by throwing himself from the window of his Parisian apartment. But before passing away, Deleuze and Guattari had created for art theory a difficult but productive visualization network that connects form to ground within subjective intuition. Their radically creative aesthetics changed the history of culture and theory and continues to give rise to new thoughts that promote the emergence of new forms of an old story: art.

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As a philosopher and anthropologist of the moderns, Bruno Latour (1947–2022) has come to attain a twin importance to the domain of new media art writ large. On the one hand, Latour’s non-modern philosophical project of de- and reconstructing established dualisms of object and subject, nature and culture, technology and society, offers up valuable conceptual resources for theorizing the affordances of digital and other new media, within and outside of their artistic mediation. On the other hand, through his long-standing collaboration with Peter Weibel in curating several multi-modal exhibition events at the Zentrum für Kunst und Medientechnologie (ZKM, Center for Art and Media) in Karlsruhe, Latour has himself become a topic of new media art–based investigation and critique. In this article, we deploy this twin figure—Latour-the-philosopher, Latour-the-curator—to take stock of Latour’s place in the practice and theory of new media art. First, we review how Latour-the-philosopher challenges received notions of technology–society as well as science–art relations, in ways that lend to new media art a specific mandate for experimenting with representations of contemporary matters of ethical-political concern. Second, we reflect on what happened to new media art in the practices of Latour-the-curator, focusing on his last major exhibition, “Critical Zones” at ZKM from May 2020 to February 2021, and delving into select artworks illustrative of broader representational tendencies. Third, we move to place Latour-the-twin-figure within the expanded field of new media art discourses, in order to probe what a properly Latourian notion of this domain’s aesthetic efficacy looks like. In de-modernizing the notion of art, we conclude, Latour at the same time restages its future stakes.

If the proverbial anthropologist of the moderns so busy at work in the writings of French philosopher Bruno Latour was to turn her keen eyes and ears onto contemporary art, carefully following its twists and turns, chances are she would soon encounter the figure of—Bruno Latour. Only during the year of 2020, Latour acted as co-curator on two major international exhibitions, both heavily steeped in new media art, however defined. At ZKM, “Critical Zones: Observatories for Earthly Politics” brought together technoscientific, artistic and eco-political mediations and representations in characteristically Latourian ways. Meanwhile, similar themes were relayed at the 12th Taipei Biennial under the title “You and I Don’t Live on the Same Planet”. In tacking along the trails of the globalized art scene, our anthropologist would likely conclude that Latour-the-curator belonged to its inner circles, surrounding himself with a host of notable contemporary artists.

Nevertheless, it remains the case that Bruno Latour derives most of his worldwide fame from the realm of philosophical ideas. As an anthropologist of the moderns’ wrong-footed separation of nature from culture, objects from subjects, Latour’s intellectual project of de-modernization has long since catapulted him to the ranks of academic superstar. This process has been facilitated by the codification of (partly) Latourian ideas into so-called actor-network theory (ANT), a conceptual package nowadays traversing the most diverse of academic fields, humanities and art history included. Closer to his premature passing in 2022, Latour restaged himself as a public philosopher of ecological crises, bent on helping formerly disconnected and insensitive humans transition into properly grounded earthlings capable of coexisting with the rest of life. If Latour-the-curator seems notable, Latour-the-philosopher is surely hard to overlook.

In this article, we reflect on the twin importance of Bruno Latour to the field of new media art that arises from the roles just sketched. As curator, Latour became important to the representational practices of new media art in distinct ways, making him a *topic* of investigation and critique. As philosopher, Latour’s non-modern attempt to de- and reconstruct established dualisms of technology and society, as noted, lends to new media art scholarship a set of *resources* for conceptualizing the affordances of digital and other new media at work in this domain. As ethnomethodologists like Harold Garfinkel were keen to point out in their sociology—much hailed by [Latour (2005b)](#b-9781474207935-027-0000147) himself—the act of uncritically conflating conceptual resources for the analytical topic of interest is likely to get us into trouble. What interests us, then, is the very doubling at work: What may we learn about the importance of Bruno Latour in the field of new media art by thinking through the twin but non-identical figure of Latour-the-curator and Latour-the-philosopher? How, indeed, do the two relate?

We organize this enquiry in three simple steps, as already hinted. First, we give an account of key tenets in Latour’s philosophy, angled in accordance with the key terms at stake: What sets “art” apart, what counts as “media”, when is something “new”? While mostly conventional wisdom as concerns Latourian thinking, we highlight also some lesser-known facets. Second, we engage critically with Latour’s practice of curating new media art. As this aspect of his oeuvre remains so far underexplored, we draw in part of our own fieldwork in the “Critical Zones” exhibition, in ways that activate our own complementary backgrounds as sociologist of science and art historian, respectively. Third, we bring these two moves and figures together, adding our own take on existing attempts to place Latour in the expanded field of new media art discourse. Here, we ask what a truly Latourian (philosophical) account of the aesthetic and other efficacy of Latourian (curatorial) practice would look like—even as we also remain aware to the possibility that Latourian (curatorial) practices might at times have overflowed or outpaced Latourian (philosophical) ideas.

## Latour as Theorist of New Media Art

Bruno Latour is the thinker of hybridity par excellence. Where previously we would see nature and the natural as set apart from the human and the cultural, we now should learn to recognize the proliferation all around us of nature-culture hybrids, assembled and reassembled from heterogeneous elements, part material, part social, part discursive ([Latour 1993](#b-9781474207935-027-0000133)). Think anthropogenic climate change and, of course, the Anthropocene. Where before we would posit technology as an inhuman force, overwhelming and alienating in its massive objectivity, we should now attune ourselves to a world in which humans and technologies exchange their properties on a mundane and regular basis. And whereas modernist epistemology taught us to see science as safely set apart from the whims of politics, ecological crises have made it obvious to all that the fate of scientific knowledge claims is intimately tied to the fate of collective life.

One suitable entry point for scenarizing the import of Latourian hybridity to questions of new media art is to pay attention to his explicit proclamations on the problem of artistic mediation and representation, of which there are a few. Most importantly in this context, arguably, is his combative statement, co-authored with fellow neo-pragmatist Antoine Hennion, on Walter Benjamin’s notion of art’s loss of aura in the age of mechanical reproduction; a *locus classicus* of art history, if any. The tone and temperament of this statement are captured already in the derogatory title, casting Benjamin as a case of “how to make mistakes on so many things at once—and become famous for it” ([Hennion and Latour 2003](#b-9781474207935-027-0000119)). The most important mistake, according to the French duo, turns out to hinge on the very question of art’s relation to technique, something that any reckoning with new media art must touch upon.

Benjamin’s argument is organized, say Hennion and Latour, around a “repetitive dichotomy” (ibid.: 92) that puts art on the side of singularity, authenticity and contemplation, while putting technique in the sense of mechanical reproduction on the side of the masses, distraction and loss of will. At root, however, technique is not mechanical reproduction. It is and has always been an active component in the chains of production, mediation and representation that become, among other things, art. This much should have been clear, they argue, since “[a]rs means technique, and this fits much more with the constant obsession of artists with their technical means” (ibid.: 93). The sound engineer knows that her technique *produces* music; it does not *re*-produce anything. The camera adds its mediations to the staged performances of actors that tie cinema to the long history of theatre. No sooner was photography invented before artists started experimenting with the myriad technical choices needed to produce prints, working on the quality of papers, the optics, the framing and so on, for aesthetical effect. At no point during its (purported) modernist trajectory did art fall from a former grace, besmirched by some all-encroaching technique.

What would a less mistaken approach to the problem of artistic mediation look like? Hennion and Latour provide a few brief yet important pointers. Most emphatically, it would *not* entail a return to some idealistic conception of art, but rather the forging of a new or *differently* materialist scrutiny of artistic production and its effects, freed from Benjamin’s Frankfurt-style and romanticist critique of modernity *tout court*. Sooner or later, however, and not unlike Benjamin, such a scrutiny would have to tackle as well all the *other* modes of delegation and mediation at work around us, of religion, economy, politics and science, modes that it would try to carefully differentiate according to their world-building capacities. All of this would amount, eventually, to a reworking of “the ever-changing definition of modernity” (ibid.: 97); one that lessens the grip, we sense, from the themes of authenticity and originality on art’s way of creating continuity between the past and the present. These latter themes are late by-products of a more basic activity, in which “[t]echnique has always been an active means of production of art” (ibid.: 94).

By drawing technical media and artistic production intimately together, in short, this Latourian argument serves to embed the very notion of new media art firmly into an extended, almost trans-historical vision. New media art, it suggests, would be but yet another turn in the long-winding history of art’s technical explorations; nothing more and nothing less. While important, however, such a long-durée recount also runs the risk of downplaying the stakes of more mundane projects. Surely, to grasp new media art as discourse and practice, we must attend to those relative shifts of emphases and interests, twists and turns in collective efforts, that matter to the unfolding of art’s trajectories at any given time and place. This is where Latour’s own fieldwork, as he likes to call it, in the world of curating has given rise also to more time-bound reflections, more attuned to the frontiers of the contemporary. Not incidentally, one such reflection is co-authored with Peter Weibel, himself a notable new media artist and director of ZKM ([Weibel and Latour 2007](#b-9781474207935-027-0000219)), aiming to provide to their jointly curated exhibitions an adequate analytical frame.

In ways both contrasted to and reminiscent of Benjamin’s aligning of mechanical art to the modern masses, Weibel and Latour’s argument is premised on aligning what they call interactive media art to the present-day conditions of the public sphere. Museum exhibitions like the ones at ZKM—concretely, Weibel and Latour address in turn their “Iconoclash” (2002) and “Making Things Public” ([2005](#b-9781474207935-027-0000141)) shows—act as suitable mediums for experimenting on what they dub “the crisis of representation” (ibid.: 106), taken in its twin artistic and political sense. Such an experimental use of the exhibition space is taken here to imply that curation happens according to precise principles that allow for raising and eventually answering key and shared questions, with artists casts as co-experimenters. This argument, in turn, is embedded into a historical narrative of the “computer-assisted information revolution” (ibid.: 107) of post-industrial society and associated shifts in aesthetic expression as well as in the forms and forums of the public sphere.

Interactive media art exhibitions, Weibel and Latour suggest in a bold vein, have become “immensely important for the new democracy” (ibid.: 102), occupying the role as public sphere once played by coffeehouses and clubs. To attain such capacities, however, artworks must at the same time shift their forms of aesthetic representation. This entails, first, a shift from what Weibel and Latour call an “aesthetics of objects” to a new “aesthetics of things”, understood as a competence shared among artists, scientists and visitors of treating artworks as heterogeneous sites of gathering together shared concerns in a public forum. Second, such a move transforms the artwork from the “closed object” of industrial modernity into the “open artwork” envisaged by Umberto Eco already in the early 1960s. Here, the artwork comes to constitute an open field of instructions for enactment, with new alliances arising between author, work and observer, and with machines and programs as co-active agents. The technical and computing arts, Weibel and Latour assert, are at the forefront of this “performative turn” in art.

In short, if by Latourian standards new media art is but another instance in the long history of art’s technical mediation, this genre is nonetheless *also* implicated in more specific shifts, allying art to science and politics in novel ways. Intersecting this claim, in turn, is Latour’s more general assertion that digitality—a major source of purported “newness” in new media art—has, as he says, “enormously increased the *material* dimension of networks” ([2011a](#b-9781474207935-027-0000150): 802). Implied here is not only the obvious if sometimes forgotten infrastructural dimensions of digital networks: no GPS without satellites, no multi-player games without hardwired connections, no financial crisis without Reuters screens. Implied is also the way digital media help render distributed action and collective phenomena *traceable* in novel ways, as instantiated into digital datascapes that allow for navigation through multidimensional landscapes of information with importance to democratic engagement. Whereas Latour cares mainly about the implications for socio-cultural research, situating himself in the vicinity of the so-called digital humanities, it seems clear that digitality opens up related possibilities for public-oriented artistic exploration.

If we are to take stock, where does this short tour through Latourian hybridity at art’s boundaries leave the notion, let alone the practice, of new media art? We will not attempt any definitive judgement; indeed, such would strike us as decidedly un-Latourian. Suffice to say that Latour-the-philosopher provides a set of concepts and reflections both deeply resonant with and at times drawn from conversations already manifested in this wider field’s ongoing attempt at self-delineation, not least when it comes to the intimate relation of art to technique. At the same time, arguably, the wider fields’ engagement with Latourian thinking has tended to remain somewhat patchy, seldom exhausting the possibilities it contains. Perhaps this situation pertains in part to the way professional art historians are prone to noticing that Latour *writes on* (as opposed to curates) art decidedly from the position of an amateur: someone not formally trained in but deeply committed to and passionate about a field of practice and thinking. Deeper engagements will rely on the willingness to translate diplomatically across intellectual domains.

One such attempt is made by Dieter [Daniels (2016)](#b-9781474207935-027-0000086) in a text that raises the question of “whatever happened to media art?” Departing from Stefan Heidenreich’s 2008 pronouncement that media art survives institutionally as “a dinosaur from the 1980s and 90s” (quoted in [Daniels 2016](#b-9781474207935-027-0000086): 46), Daniels in turn enlists Latour’s alternative account of modernity to arrive at a critical angle to the “epidemic of ‘post’-ness” (post-media, post-digital) (ibid.: 62) at work in reflections on contemporary art writ large. Latour, in Daniels’ account, sees modernity “not as a radical break with the past”, but rather as an “iterative model where hybrid conditions are continually translated and interconnected” (ibid.: 49). Starting as Latour’s way of thinking about science, this understanding in turn proves useful, Daniels suggests, to art theorists. In particular, it affords an understanding of media art as indeed “a hybrid area” where, in the early days, “multiple interdisciplinary cross-connections and collaborations” across culture, technology, society and science “were possible without forming a common conceptual or strategic identity” (ibid.: 50). Nowadays, “dinosaur” institutions like ZKM, Daniels suggests, should be documenting and preserving this recent past; even as, going forward, the divide between “old-new” media art and “mainstream” contemporary art “will become more fuzzy than ever” (ibid.: 63).

Similar themes are relayed in Scott McQuire and Natalia Ratywyl’s ([2010](#b-9781474207935-027-0000181)) reflections on the intersections of art, digital technology and temporality. In a trajectory that starts, like Latour’s own, with Eco’s notion of the open artwork, McQuire and Ratywyl enrol Latour to the effect that, in a definite break with the avant-garde model, artists today attain the more modest role of hosting public dialogues about and for “the non-linear complexity of a heterogenous present” (ibid.: 23). When “everything is contemporary”, as [Latour (2005a)](#b-9781474207935-027-0000141) states, contradictions are forced to coexist, as they “can no longer be displaced onto the supposed backwardness or belatedness of the periphery according to a supposedly universal logic of historical progress” characteristic of “colonial modernity” ([McQuire and Ratywyl 2010](#b-9781474207935-027-0000181): 23). While video art, in particular, risks being caught up in the commodity logics of the “experience economy”, museums may also act, in the language of Peter Weibel, as *counter*-publics, spaces in which people may learn and experience in ways not afforded elsewhere. While the language here bears more traces of “critique”—of colonialism and commodity fetishism—the connection to Weibel and Latour’s ([2007](#b-9781474207935-027-0000219)) own reflections are obvious.

To reiterate, our interest here lies less in adding our own take to these existing interventions than in noting the possibilities they offer when it comes to diplomatically extending the mutual encounter of new media art with Latourian conceptual hybridity. Moreover, we keep open for now the possibility that, as we switch our focus from Latour-the-philosopher onto Latour-the-curator, we may have to revise somewhat the contours of the encounter just sketched. There seems little doubt that Latour has found, over many years of practice, an important set of felicitous conditions in his ZKM–Weibel–new media alliances for exploring his philosophical themes by *other*, artistic means. These include not only art–science and technology–society relations, but also and increasingly his concern with the conditions of eco-politics in the Anthropocene. While thus certainly an ally and promoter of new media art, the critical questions should still be raised: What exactly is being promoted, and what is being elided, in the work of Latour-the-curator?

## Latour as Practitioner of New Media Art

Over the years, Latour co-curated a total of four multi-modal exhibitions at ZKM: apart from the three already mentioned—“Iconoclash” (2002), “Making Things Public” ([2005](#b-9781474207935-027-0000141)) and “Critical Zones” (2020)—this counts the “Reset Modernity!” show in [2016](#b-9781474207935-027-0000086). As one of Europe’s prime institutions of new media art, ZKM prides itself of accommodating all the stages of its production, from research, presentation and collection to publication and archiving ([Weibel and Latour 2007](#b-9781474207935-027-0000219)). This chain of cross-fertilization has certainly been at work also in Latour’s ZKM engagements, blurring the boundaries between exhibition, research and philosophical intervention in a format that he has come to promote as “thought exhibitions” (*Gedankenausstellungen*). Yet, while these recurrent acts of collective experimentation, thinking and expression was clearly important to Latour’s own conception of his overall oeuvre ([Blok and Jensen 2011](#b-9781474207935-027-0000083)), his curatorial forays into contemporary media art have so far received comparatively little academic or art-critical attention.

Nevertheless, to help frame some important art-critical parameters, it is instructive to contrast the divergent appraisals by Frank [Maet (2013)](#b-9781474207935-027-0000175) and Caterina [Albano (2018)](#b-9781474207935-027-0000078) of the “Making Things Public” exhibition, its aims and its effects. To Maet ([2013](#b-9781474207935-027-0000158): 118), Latour-the-curator essentially fails to achieve what ought to be achieved under that rubric, that is, to stage possibilities for “a critical distance” towards today’s pervasive electronic media environments to emerge. Instead, Latour’s “anti-modernism” compels him, Maet suggests (ibid.: 122), to add to rather than to ameliorate the opacities and oppressions of this technological situation, failing to “(re-)humanize” our media-immersed being. Symbolic of this, in Maet’s view, is the installation work on the *Phantom Public* specifically designed by Michel Jaffrennou and Thierry Coduys for the exhibition: a largely invisible work of electronic sensors, sounds and lights meant to trace and react to the shifting flows of visitors in the exhibition, thereby creating the sensation of being tied together collectively by bonds only obliquely of one’s own making. In Maet’s reading (ibid.: 112–14), this work, and the exhibition overall, inadvertently plays along with a functionalist and de-politicized rendering of media’s role in governance and everyday life. Not surprisingly, this reading of Jaffrennou and Coduys’ work contrasts starkly with Latour’s own ([2005a](#b-9781474207935-027-0000141)), as he took great pride in the work’s ability to re-mediate pragmatist ideas from Walter [Lippman’s (1925)](#b-9781474207935-027-0000172) take on the fate of publics in media-saturated mass societies. The idea of the work, according to Latour ([2005a](#b-9781474207935-027-0000141): 28), is to grant “more reality” to the fragile existence of heterogeneous publics in contemporary societies, thereby edging towards their *enhanced* political capacities.

The implicit exchange is interesting, we argue, for telling us something about the *theory dependency* of Latour-the-curator’s exhibition practices and their conditions of felicitous, art-critical appraisal. This point is further clarified by the rather contrasting reading of the “Making Things Public” exhibition provided by Caterina [Albano (2018)](#b-9781474207935-027-0000078). Whereas Maet places the exhibition squarely in the lineage of media criticism, invoking Marshall McLuhan and Maurizio Ferraris, Albano situates it rather in the modernist lineage of analogies between the artistic exhibition and the scientific experiment. Whereas in the 1940s, Alfred H. Barr Jr. invoked this analogy as part of placing New York’s Museum of Modern Art within a cultural imaginary of innovation and universality, Weibel and Latour deployed it at ZKM from the 2000s onwards rather to index a situation of performativity, contingency and plural perspectives. Underlying this difference are far-reaching shifts effectuated in the meantime in dominant cultural understandings of science, art and politics; understandings to which Latour’s own field of science studies has significantly contributed since the 1960s ([Seth 2020](#b-9781474207935-027-0000191)). In Albano’s words ([2018](#b-9781474207935-027-0000078): 112), knowledge production in experimental science has come to be seen as “a flow of interaction not fully determinable”—and this situation opens up new possibilities of art–science engagement. She rightly cautions, however, that such cross-fertilization “also contains its own disturbance” (ibid.: 113). Experimental exhibitions such as “Making Things Public”, Albano stresses, force a continued questioning of the authority they confer on both the laboratory and the museum as sites of knowledge production and the politics of alliances and vested interests that feed such reciprocal projects. What possibilities for renovating institutionalized commitments do they open up or close down?

This question and its art-science lineage strikes us as pertinent also when it comes to Latour’s co-curated [2020](#b-9781474207935-027-0000130) exhibition on “Critical Zones” ([Latour and Weibel 2020](#b-9781474207935-027-0000169)), to which we now turn in a more ethnographic vein. Doing so, we also keep with us a related version of the question emerging from Maet’s critique: put bluntly, to what extent might it be the case that the theoretical ideas of Latour-the-philosopher not only inform and inspire, but also at times risk overdetermining and stifling the questions addressed by new media and other artists *themselves* within the shows he (co-)curates? We raise this question in part since, curiously, what art-critical engagement has pertained to Latour’s curatorial practices has largely failed to engage with the actual artworks on display. Also, we ourselves ([Thorsen and Blok 2016](#b-9781474207935-027-0000204)) responded to Latour’s previous exhibition on “Reset Modernity!” by suggesting that such tensions in curator–artist relations—well-known, of course, from wider conversations on contemporary art (e.g. [Vidokle 2010](#b-9781474207935-027-0000214))—were in fact important to the overall exhibition. Specifically, we argued ([Thorsen and Blok 2016](#b-9781474207935-027-0000204)) that “while *thoughts* are literally put on *display* [in the exhibition], it seems as if nothing much *experimental* is happening here. In particular, the detour through other materials [the artworks] seems to make no real difference to how the thoughts [of Latour] unfold themselves”. Might things have changed with the “Critical Zones” exhibition?

Importantly, “Critical Zones” marks a clear extension and resituating of Latourian themes firmly onto the territory of contemporary eco-politics, characteristic of his later work (e.g. [Latour 2017](#b-9781474207935-027-0000166)), while also representing a partial return to earlier concerns with following scientists through society. The notion of the critical zone that lends the exhibition its title refers to a scientific network and practice of establishing place- and landscape-based observatories to study the soils, air circulations, geological formations and water streams making up the conditions of cohabitation for life itself, humans included. For some years prior to the exhibition, Latour was following in the trails of these soil scientists, geologists, hydrologists and others, whom he collectively referred to as the critical zonists ([Latour 2014](#b-9781474207935-027-0000161)). In doing so, he was instrumental in linking this work to what he considered an epoch-defining scientific paradigm shift, the Gaia hypothesis of James Lovelock and Lynn Margulis in the 1960s and 1970s, according to which it is biological life forms that actively constitute the atmospheric conditions of the Earth. The “Critical Zones” exhibition, in short, is dedicated to exploring these scientific ideas in their intersections with art and eco-politics.

From an art-critical perspective, it is worth noting that “Critical Zones” marked the culmination of a trajectory whereby Latour-the-curator increasingly brought established and indeed world-renowned contemporary artists, including new media artists, into his shows. Whereas earlier shows were peopled as much by artistic amateurs—including, incidentally, a host of socio-cultural scientists!—by the time of “Critical Zones”, the exhibition space of ZKM and the attendant catalogue reads more like a “who’s who” in contemporary video, digital and installation art. Also, the share of works actually commissioned and produced specifically for the show, relative to pre-existing works, seems higher here than before (although we did not count this in detail). Suffice to say that, relative to our own critical assessment of the “Reset Modernity!” exhibition, conditions for more productive, or at least more equal and mutually challenging, interplays across artistic explorations and Latourian curatorial ideas seem in place for the “Critical Zones” show. Indeed, we think such productive encounters manifest much stronger.

To illustrate what we take to be at stake in these concrete encounters, we focus here on three cross-cutting themes or platforms of art-science collaborations in eco-politics at work in the exhibition. This breakdown relies on but also deviates somewhat from the curatorial set-up of the exhibition into six sections. As such, it represents our attempt to analyse the exhibition space as symptomatic of wider tendencies and possibilities. We refer to the three cross-cutting themes as *science-based pedagogies*, *contested earthly territories* and *neo-sublime nature vistas*, respectively. In what follows, we pick what we consider an exemplary artwork for each theme, unfold what we take to be its key material and conceptual import, and then relate this to Latourian themes at work curatorially in the exhibition. We are particularly interested in points where the artworks may overflow or subtly challenge the latter, as we take this to indicate some of the boundaries and premises shaping the encounters.

The *Critical Zones Observatory Space* created by architects and graphic designers Alexandra Arènes and Soheil Hajmirbaba is emblematic of what we are calling science-based pedagogies, as a platform for exchange across knowledge registers. The work is essentially a scale model of the Strengbach critical zone observatory, located 150 kilometres from Karlsruhe and ZKM. The multiple infographics, videos and digital data displays are meant, in the language of the curators, to allow visitors “to experience, as close as possible, how scientists themselves follow the behavior of some of the phenomena making up a landscape” ([John 2020](#b-9781474207935-027-0000130)). Extending arch-Latourian themes, visitors are thus invited to see and feel the land as scientists do, using multiple layers of technical equipment and mediation that render otherwise invisible features such as water cycles, forest evolution and chemical pollution visible. The iconography of the work is in this sense entirely realist, yet based on the premise that to most “ordinary” visitors, the scale model provides “an alternative sensorium” (ibid.) that mediates across the science–lay divide. Implicitly, we suggest, it promotes a pedagogy of the senses that seeks to emulate scientific vision.

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While such premises might indeed provide interesting mandates also for artists to explore, what is perhaps most striking about the *Critical Zones Observatory Space*, however, is the rather conventional contrast it conjures in the process, as just hinted. In the language of the curators, the view attained from the work “is very different from a tourist’s view of a Vosges landscape” ([John 2020](#b-9781474207935-027-0000130)). Rather than *challenging* the science–lay divide by artistic and aesthetic means, then, new media art is tendentially enrolled here primarily in its pedagogical capacities of extension and mediation of science to new publics. To be sure, this work and the wider exhibition are not alone in doing so; indeed, one of us has argued elsewhere that such tendencies to underestimate the capacities of aesthetic experience to trouble, reshuffle and recompose common-sense *and* scientific knowledge registers are rather an endemic risk in art-science collaboration ([Thorsen 2016](#b-9781474207935-027-0000199)). For new media art to host truly productive encounters, in short, would in our view mean a willingness to put established scientific registers into more playful, provocative and speculative encounters than what Latour-the-curator here mandates.

Turning to contested earthly encounters, we take the *Kuannersuit/Kvanefjeld* work by Lise Autogena and Joshua Portway as standing for a somewhat more affirmative move in exactly this direction, one that seems to productively overflow and thus escape its Latourian overdetermination. Cast as an evolving archive of research undertaken by the artists and their collaborators, the work explores a number of interconnected artefacts, interviews and texts that refract the highly contentious debates surrounding the possible construction of a mine near the town of Narsaq in South Greenland. Mediated through a simple and interactive digital-visual display, the work invites the visitor to move through fragments of international treaties, real-time stock tickers, radioactive rocks, children’s toys, political tweets, narratives from locals and more. Extending well beyond its material ZKM installation, the work spills into a series of digital platforms, including a so-called Narsaq International Research Station that invites independent cultural and scientific research on “an area of outstanding natural beauty and cultural heritage” that is “central for understanding some of the most urgent challenges the world is facing today” (quoted on [<www.narsaqresearchstation.gl>](www.narsaqresearchstation.gl)).

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While we cannot do justice to this richly faceted work here either, we want to make three brief observations in this context, pertaining to the intersection of new media art with Latourian themes. First, while the work is hosted in a deliberately retrograde digital interface, the experience of moving through its fragments catapults the visitor from touching human empathy to scientific curiosity, and from political indignation to technological awe. Here, affective-aesthetic experience and mediation of a highly localized, highly charged eco-political landscape are incontrovertibly put centre stage, ahead of any theoretical closure. Second, and related, the far-from-glitch-free, retrograde and somewhat resistant digital interface itself cannot help but strike us as a partly ironic, partly caring commentary on the kinds of fantasies projected, including by Latour and other digital humanities scholars, of how new technologies will purportedly allow smooth public navigation through a world of inconsistencies. Thirdly, as hinted, the work rather explicitly turns the table on standard art–science relations, making art-based research the central host rather than the late addition to such endeavours. As such, more strongly than Latour-the-curator, the work makes itself responsible to those questions of authority that [Albano (2018)](#b-9781474207935-027-0000078) brings forth.

Finally, we end our commentary with the *Perimeter Pfynwald* work by Marcus Maeder, an acoustic-artistic installation work that we place, mirroring the “Critical Zones” curators, in the theme and lineage of neo-sublime nature vistas. In this work, Maeder captures sounds of the Pfynwald forest in Switzerland by placing recorders in four different biotopes, thereby enabling a multi-sonic experience of how drought and heat affect the forest’s soundscapes as the seasons change. Promoting this as a practice of environmental listening, the work becomes in part a commentary on and a sensorium for experiencing ongoing climatic changes and their impacts on the forest landscape. We listen as the fauna changes or retreats, mountain streams dry up and the forest’s main river becomes louder with increasing meltwater from glaciers. At the same time, the micro-climatic measurements and their sonic mediation also generate their own composite and synthetic forest voice, deployed through acoustic time-lapse techniques, thus affording sensorial experiences that one could not possibly have by placing one’s body in the forest itself. In this way, silences, sonic tonalities and intensifications attain their own distinct qualities.

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Our rather commonplace observation here is that Maeder’s shift of medium and sensorial register, from sight to sound, harbours powerful aesthetic possibilities that are *also* (and this is our point) key and integral to Latourian eco-politics. Attuning to the Earth through the sounds it emits is arguably to prefigure a process of bodily recomposition that is integral to what it will mean to live, to struggle and to survive in the Anthropocene (viz. [Latour 2004](#b-9781474207935-027-0000136)). Maeder’s work is “neo-sublime” in this sense, we believe, since it allows for an auditory and imaginative passage from the micro- to the macro-climatic, that is, from the embodied experience of a given landscape to conditions of life on Earth as such. Considering just how central this passage is for Latour’s own eco-political argument on Gaia, we consider it striking to note that most of the “Critical Zones” exhibition remains faithful to the well-trodden reality-effects of the video medium, prioritizing ocular engagements even where sounds would work as a complement. Here, Maeder’s would be one of only few works to hint at still-underexplored capacities of new media art to contribute to the Latourian project of building aesthetically multi-sensorial connections to Earth.

To summarize, even as we borrow freely from its register, our comments here should be read less as standard art criticism and more as analysis of the inspirations and elisions stemming from the close encounter of new media art with Latourian curatorial practices. While valuably serving to channel art–science encounters onto the ever more central domain of eco-politics, the “Critical Zones” exhibition, we argue, also embodies some of the difficulties entailed for new media artists in engaging the twin-but-non-identical figure of Latour-the-philosopher and Latour-the-curator. More than anything, we suggest that new media artists among them possess aesthetic capabilities that far exceed their Latourian encoding, in *both* (philosophical) theory *and* (curatorial) practice. By stating this, we certainly in no way wish to detract from a highly valuable oeuvre that should, we believe, remain a constant source of artistic (and other) inspiration for many years. We simply wish to keep open the possibility that Latour’s is not the final word on the aesthetic efficacies that he clearly valued. We turn now, lastly, to consider this question more directly.

## Latour in the Expanded Field of New Media Art

The preceding account of the twin role of Bruno Latour’s work in and on the field of new media art discourse and practice is deliberately designed to raise *and* complicate the following key question: How to appreciate or evaluate this importance? Following the philosophical direction might well lead us down a classical epistemological route, predicated on questions of conceptual and empirical validity. By contrast, following the curatorial direction would seem to pose the equally classical question of aesthetic validity, understood for now in the Kantian vein as judgements of taste that appear plausible by way of appeals to common sense (*sensus communis*). Yet, while we have stressed their non-identity, we have also stressed the rather obvious twinning of these two roles and their attendant validity registers in the combined oeuvre of Latour. If anything, the constant traffic effected by Latour between conceptual and aesthetic engagements might lead us to consider the two as closely related and mutually reinforcing registers. Indeed, Latour’s explicit reflections on aesthetics would support such an intuition (e.g. [Latour 2011b](#b-9781474207935-027-0000155)).

These divergent possibilities are mirrored, perhaps unsurprisingly, in existing attempts by cultural scholars to place Latour in the expanded field of new media art discourse and practice. Here, a heuristic distinction might be made between minimalist and maximalist versions of this emplacing. Along the minimalist route, scholars engage with one or other specific trait of Latour’s conceptual universe, praising its ability to push new media art thinking and practice in new directions. We have already seen examples of this style of engagement: to [Daniels (2016)](#b-9781474207935-027-0000086), Latour’s importance lies in his rethinking of science and modernity (as iterative, hybrid and constantly translated), whereas to [McQuire and Ratywyl (2010)](#b-9781474207935-027-0000181), it lies in his rethinking of time and contemporaneity (as non-linear and heterogeneous coexistence). More basic still, Ewa [Wójtowicz (2019)](#b-9781474207935-027-0000225) credits Latour’s ANT with having provided the theoretical model according to which technological infrastructures are indeed vital actors in the contemporary world—thus lending credibility to new media artists’ efforts of exploring and interfering with the bits and cables of digital culture. Minimalist appraisals come also in the negative, as we have seen in the case of [Maet (2013)](#b-9781474207935-027-0000175).

By contrast, the maximalist version of appraisal is exemplified most vividly by art theorist Francis Halsall, who, in a string of publications ([2012](#b-9781474207935-027-0000098), [2016](#b-9781474207935-027-0000086), [2019](#b-9781474207935-027-0000108)), has argued that there are strong “conceptual rhymes” between Latour’s philosophical thinking and the world of contemporary art writ large. To Halsall, this homology goes both ways. Hence, it is not only that one finds in contemporary art a conception and practice of aesthetics that rhyme with how Latour has redescribed the world, in terms of dispersed networks and subjects. It is also, claims Halsall, the case that Latour works and writes *like an artist*, in that his “modes of analysis mirror the methods and style of contemporary artistic practice” ([2016](#b-9781474207935-027-0000086): 440). This claim has deeper implications: what Latour exemplifies, according to Halsall, is that the line separating epistemological and aesthetic questions has become blurred at best in both fields, that is, in both philosophy and contemporary art. In the language we have used so far, the close twinning of Latour-the-philosopher and Latour-the-curator is thus, to Halsall, a synecdoche for a much wider phenomenon—namely for what he calls “the position of art in the aesthetic milieu of the age of the world system” ([2019](#b-9781474207935-027-0000108): 208).

We want to draw our article to its close by way of a critical-constructive engagement with Halsall’s incisive argument which, we believe, nonetheless misses its mark in important ways. Doing so will allow us to add our own sketch of an answer to the question of what a truly convincing Latourian conceptualization of new media art’s aesthetic efficacy—and hence also of his own curatorial practices—might look like. While developing a full response is beyond the scope of this article, the gist of our argument will be that to do so necessitates a break with the Kantian tradition of philosophical aesthetics to which Latour remains, perhaps inadvertently, tied (and which lingers explicitly in Halsall’s appraisal). Rather, it would mean extending Latour’s interest in pragmatist philosophy to the aesthetic realm, to follow in the footsteps of John [Dewey’s (1934)](#b-9781474207935-027-0000095) classical work on *Art as Experience*. Such, we argue, would afford an opportunity to at once de-centre art and re-centre aesthetics-as-experience as central to Latour’s project of de-modernizing, in general, and his strivings to cross-fertilize science, art and eco-politics in particular.

To facilitate this argument, it works to separate two strands in Halsall’s claims which he sees as closely related but which we believe to be better treated as relatively distinct. One is the claim about conceptual rhymes between Latour and contemporary art, including new media art; this claim, in our view, contains many pertinent observations resonant also with how we have presented matters. The other is the claim about aesthetics and the role of aesthetic judgement in philosophy, art and culture writ large; here, we find it hard to square Halsall’s argument with either Latour’s aesthetic theory or indeed our own pragmatist inclinations. Since it is the latter claim that makes Halsall’s a maximalist appraisal of Latour’s import for new media art, we will spend less time than we might otherwise on the first point in order to get to the second.

Halsall valuably detects a number of conceptual rhymes between Latour and contemporary art that go beyond the kinds of society-technology, culture-nature, subject-object hybridity that we have so far stressed. Overall, this is tied together by an eclecticism of medium, style and modes of production characteristic of contemporary art which, he claims, is mirrored in how Latour and ANT redescribe the world: as fluid and diverse networks of humans and technologies that promulgate via promiscuity in collaborative partnerships. The strategy of both ANT and contemporary art, in short, “is to use aesthetic practices to complicate the world and reconsider its structures, relations and subjects” ([2019](#b-9781474207935-027-0000108): 201). In turn, Halsall associates such interactions and developments with a number of art-theoretical discussions, including Peter Osborne’s notion of the “post-contemporary”, Rosalind E. Krauss’s account of art after modernism as being in a “post-medium” condition, and Nicolas Bourriaud’s much vaunted defence of “relational aesthetics”. Taken exactly as rhymes, that is, as recognizable broad-stroke patterns of thinking at work in both Latour’s philosophy and contemporary art, we would agree with this kind of reading.

Where we find Halsall less convincing is in arguing that, to Latour, there exists an *equivalence* between art and science as modes of enquiry equally necessary for facing the ecological crises of the Anthropocene ([Halsall 2016](#b-9781474207935-027-0000103): 444). It is certainly true that, as we have seen, Latour found contemporary art eminently *useful* to science (his own included) as a means of extending his philosophical enquiries in multiple directions at once. It is also true that, in Latour’s view, we need now for *all* the collective competencies we can muster—from science to art, religion, technique and politics—to *work together* in novel ways in order to increase our chances of avoiding what Isabelle [Stengers (2015)](#b-9781474207935-027-0000197) terms “the coming barbarism”. Yet, it does not follow that Latour would not accord to contemporary art and, more generally, to aesthetic expression, mediation and representation a rather *specific* role or capacity for assisting such work of collective diplomacy. In fact, such a reading goes against the grain, we think, of Latour’s own proclamations on aesthetic efficacy; and thus fails, ultimately, to help us consistently de-modernize art.

The most explicit statement on these matters, arguably, is found in [Latour’s (2011b)](#b-9781474207935-027-0000155) comments on the art of Tomás Saraceno and his *Galaxies Forming along Filaments* installation. Latour reads this work as solving a conceptual problem in thinking about globalization. More importantly for our purposes, he invokes the aesthetic theory of Gilles Deleuze and Félix Guattari as underpinning: “As Deleuze and Guattari have shown, a *concept* is always closely related to a *percept*. By modifying our percept, *Galaxies Forming along Filaments* allows those who try to redescribe the loose expression of globalization to explore new concepts” ([Latour 2011b](#b-9781474207935-027-0000155)). Latour nowhere expands on this argument; neither does he go on to explore in any detail its famously associated definition of the artwork as “a bloc of sensations, that is to say, a compound of percepts and affects” ([Deleuze and Guattari 1991](#b-9781474207935-027-0000092): 164). What he does, we believe, is to open up a door for further exploring a set of non-Kantian “rhymes” in aesthetic theory. This would, we argue, eventually lend specificity to aesthetic experience as a key modality of exploring a hybrid world, including in new media art—and beyond Halsall’s singularly Kantian obsession with judgements of taste.

Again, unfolding this point in full is beyond the scope of this article. Suffice to join Melanie [Sehgal (2018)](#b-9781474207935-027-0000186) in her discussion of aesthetics in the work of the aforementioned Stengers, a well-known philosophical friend of and mentor to Latour. As Sehgal points out, one finds in Stengers not so much an unfolded aesthetics as an engagement with a string of non-Kantian thinkers for whom aesthetics was in fact “first philosophy”, a matter of priority: Félix Guattari’s new aesthetic paradigm, John Dewey’s association of art with experience, and Alfred N. Whitehead’s stress on overcoming the so-called bifurcation of nature into primary and secondary qualities. Extrapolating, Sehgal suggests that to Stengers, aesthetics can be no longer confined to a special realm of society—such indeed as “art” or “the art-world”—but should rather be seen as transversally cutting across every domain of experience. Moreover, Stengers resists any reduction of aesthetics to “a strictly ethical question” (quoted in [Sehgal 2018](#b-9781474207935-027-0000186): 117). Instead, aesthetics “designates first of all a production of existence that concerns one’s *capacity to feel*: the capacity to be affected by the world, not in a mode of subjected interaction, but rather in a double creation of meaning, of oneself and the world” ([Stengers 2000](#b-9781474207935-027-0000194): 148). We would add that such a definition is close, indeed, to how [Dewey (1934)](#b-9781474207935-027-0000095) saw aesthetic experience as a situated quality of unified feelings and perceptions of the world, tied to an experiential continuum running from moments of insight in everyday life to encounters with carefully crafted works of art.

In sum, our suggestion is that, as in the case of Stengers, we may detect in Latour’s both philosophical and curatorial work the incipient beginnings rather than the fully-fleshed contours of a redistributed and de-modernized aesthetic thinking compatible with the rest of his project. Articulating such connections would serve, in turn, to place Latour into conversations already manifest in new media art discourse on the importance of aesthetic experience as mediating the performative ([Hsieh 2011](#b-9781474207935-027-0000125)) and indeed intercultural ([Vandelabeele 2004](#b-9781474207935-027-0000209)) capacities and aspirations of this field. More specifically, it would lend to Latour’s philosophical project a stronger justification for the importance of his own curatorial practices, as well as a means of reconsidering these practices in light of an already allied pragmatist lineage that might act as the kind of sympathetic challenger that we ourselves have tried to embody throughout this article. Overall, it points the way ahead, we believe, to a stronger Latourian presence in the future of contemporary art—freed at last, one might hope, from the need to proclaim its own “newness”.

## Conclusion

Let us end by paraphrasing the philosopher Graham [Harman (2016)](#b-9781474207935-027-0000114): what Bruno Latour ultimately offers to new media art is the promise of de-modernizing—decidedly *not* in the sense of returning to some idealist neverland of non-technological art but, on the contrary, by ridding the field of all lingering assertions of such a distinction to begin with. Such is all part, we might say, of accepting the claims of hybridity: of radically redistributing all the elements of the world that used to be summed up in the dichotomous containers of nature and culture, technology and society, objects and subjects. Doing so, however, does not entail some simplistic “immanence”, as if everything might suddenly be seen as equivalently caught in a single and unified field of forces. On the contrary, [Latour (2013)](#b-9781474207935-027-0000158) invites the field to relearn all the important world-building capacities, of science, politics, religion and art itself, mobilizing them as allied-but-divergent registers for exploring the margins of livability on an ecologically troubled planet.

In juxtaposing the twinned-but-non-identical figures of Latour-the-philosopher and Latour-the-curator, we have tried to show that Latour’s overall oeuvre contains within itself the seeds of its own aesthetic overflowing, in ways that might further solidify his already impressive contribution to new media art. We intend this intervention in the spirit of a forward-looking proposition: if the field of new media art discourse and practice is to take full advantage of the gift that is the Latourian de-modernizing project—and we certainly hope it will in years to come—then the latter should at the same time remain open and available to the possibility of learning from its own art-based and aesthetic encounters. Rather than casting Latour’s philosophy and contemporary art as already fully aligned, then, we have pinpointed those gaps opened up by his curatorial encounters with new media art practices that may exceed and overflow the philosophy’s parameters. We have tried to do so from the position of a sympathetic but challenging co-explorer. Such is ultimately the mandate, we argue, that a fully worked out Latourian conceptualization of the aesthetic efficacies of new media art lends to its own practice—turning the topic of Latour into a renewed resource.

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Donna Haraway’s Cyborg Manifesto is one of the most important contributions to our understanding of the meaning and potential of digital technology, particularly in relation to gender. It was first published in 1985, when, following the Soviet invasion of Afghanistan, international tensions led to a massive arms build-up and a renewal of Cold War anxieties and tensions. This period also saw huge shifts in the structure of capitalism, involving deregulation, restructuring, leading to the so-called “post-industrial society”. This was bound up with the massively increased presence and use of digital technology, originally developed in the context of the earlier periods of the Cold War.

In the 25 years from the end of the War to 1970 computers went from vast, unwieldy and expensive machines, requiring highly specialized knowledge to operate, to something close to the machines we are now familiar with. This was not just a quantitative change, but a qualitative one as well. The development of real-time graphical computing and digital networks, driven largely by the needs of the Cold War, transformed computing entirely and laid the ground for future developments such as the personal computer and the Internet and, by extension the future shape of digital culture.

— ([Gere 2008](#b-9781474207935-028-0000138): 78)

## Feminism and the Cold War

Perhaps unsurprisingly, given its Cold War context, digital technology remained highly gendered. The sociologist Sherry Turkle undertook an important study of computer culture and its relation to perceptions of selfhood, which was published in 1984 as *The Second Self: Computers and the Human Spirit*.

There are few women hackers. This is a male world. Though hackers would deny that theirs is a macho culture, the preoccupation with winning and of subjecting oneself to increasingly violent tests makes their world peculiarly male in spirit, peculiarly unfriendly to women. There is, too, a flight from relationship with people to relationship with the machine – a defensive maneuver more common to men than to women. The computer that is the partner in this relationship offers a particularly seductive refuge to someone who is having trouble dealing with people. The machine is active, reactive, it talks back. Many hackers first sought out such refuge during early adolescence, when other people, their feelings, their demands, seemed particularly frightening. They found refuge in the computer and never moved beyond.

— ([Turkle 1984](#b-9781474207935-028-0000191): 210)

Out of these circumstances new conceptions of the machinic and possible new relations with technology began to be articulated within feminist discourse. Feminism in its contemporary form also emerged in this context. It was in the mid—to late 1960s that the beginnings of the American version of Feminism, along with a number of similar movements in Great Britain and mainland Europe, brought issues of gender and power into question, particularly, of course, in relation to the subordinate position of women in society. Like many complex social movements Feminism was neither a simple nor a unitary phenomenon. It was, and remains, a term under which different groups with often opposing agendas could be corralled.

Nevertheless a number of issues can be said to demark and define Feminism as it emerged in this period. These include a questioning of the assumption of male dominance within society, and of women’s inferior status and their relegation to passive, largely domesticated roles, as well as opposition to discrimination, in relation to contract and property rights, employment and pay, and management of earnings, and demands for the right of control over the care of the body, particularly in relation to sex and childbearing.

At one level there was a straightforward antagonism between second wave feminism and (male) technology. Perhaps the most cogent confrontation between the two took the form of the peace camps at the Greenham Common military base in the UK. Greenham Common in Berkshire had been a military airbase in the Second World War, used by both the British and American air forces. In 1951 it was given over to the Americans and, from 1983 onwards, was used to store nearly a hundred nuclear-armed cruise missiles, with enough yield to destroy the world. The plan to store the missiles there had existed since the late 1970s and the first peace camp was established in 1981, after the Women for Life march from Cardiff to the Berkshire site. The peace camp endured from its founding to 2000, even though the missiles were removed in 1991. As Christina Welch points out the camp had a considerable spiritual dimension, even though this is little discussed in the relevant literature. The camp took the form of separate encampments at each of the site’s gates, all colour-coded by the protestors, and each with its distinctive cultural and/or sexual character. Green Gate was “seriously lesbian” and, as Welch puts it, “was also perceived of as New Age and/or mystical”. Ann Pettitt, a founder member of the camp and one of the Cardiff walk initiators, described Green Gate as a gate for “women who liked to commune with all sorts of sprites and spirits” ([Welch 2010](#b-9781474207935-028-0000197): 233), while others have termed it, “Cosmic, where women interested in spirituality … clustered” ([Roseneil 1995](#b-9781474207935-028-0000178): 80). Many of the activities that took place at the camp, such as the weaving of a four and a half mile long serpent that was threaded around the perimeter fence in 1983, can be seen to relate to, for example, Mary Daly’s connecting women and weaving. Daly was a radical feminist and theologian, best known for her groundbreaking work *Gyn/ecology: The Metaethics of Radical Feminism* ([1979](#b-9781474207935-028-0000124)).

Protestors would also agree to take the oath when in court, as long as it was to the “Goddess”. One of Welch’s points, drawing on the work of anthropologist Tanya Luhrmann, is that the role models were what Luhrmann terms “ugly goddesses”. She points out how ‘the Goddess is often conceptualized in ritual practice and in literature through the three phases of the moon: the waxing moon as the virgin huntress, the full moon as the mother/lover, and the waning moon as the hag, who destroys’ ([Luhrmann 2001](#b-9781474207935-028-0000155): 120).

The last, the “Old Woman, the hag, initiates the death that enables life to feed on death: she gives to us the recognition of the need for death. The practitioner is supposed to see this aspect of the goddess in old age, loss, pain, and sorrow, and also in irrational rage, lust, violence, menopause, and, sometimes, the experience of menstruation itself” (ibid.: 121). She suggests that many “who were involved with Goddess spirituality were very involved with the third aspect of the Goddess, with the Goddess as death, underworld, and destruction” and she suggests that much of the literature on the goddess focuses on this aspect. It was about this time, in the mid-1980s, that scholar and activist Silvia Federici began work on the relation between the witch-hunts in the late medieval and early modern periods and the rise of modern capitalism ([Federici 2014](#b-9781474207935-028-0000127)).

## Goddess Spirituality

In the Manifesto Donna Haraway famously proclaimed that she would choose to be a cyborg than to be a goddess ([Haraway 1991](#b-9781474207935-028-0000149): 181). In discussing Haraway’s ideas it is unusual to focus on the second part of that pairing, the goddess. Yet I think it can add to our understanding of Haraway’s radicality if we put her invocation of a divine female figure in context. This is not an arbitrary reference or comparison on Haraway’s behalf, but a response to a powerful and influential strand of Feminism during the 1970s and 1980s.

Goddess spirituality is perhaps most closely connected to a handful of Feminist thinkers, pre-eminent among them Carol P. Crist, Monica Sjöö, Starhawk and Mary Daly. Among the founding moments of this movement is Crist’s keynote speech at the “Great Goddess Re-emerging” conference at the University of California Santa Cruz in 1978, published as “Why Women Need the Goddess” in *Heresies: A Feminist Publication on Art and Politics* in the same year. She ends her address thus:

The symbol of the goddess has much to offer women who are struggling to be rid of the ‘powerful, pervasive and long-lasting moods and motivations’ of the devaluation of female power, the denigration of the female body, distrust of female will and denial of the mother-daughter bond and women’s heritage that have been engendered by patriarchal religions. As women struggle to create a new culture in which women’s power, bodies, will and bonds are celebrated, the symbol of the Goddess naturally reemerges and speaks to the deep mind, expressing our new vision of the beauty, strength and power of women.

— ([Crist 1978](#b-9781474207935-028-0000119): 13)

Goddess spirituality tended to see technology as one of the forces working to further women’s separation from nature. This view, which resonated with contemporary ecological concerns, posited a privileged relationship between femininity and nature. One of the most trenchant critics of modern technology was Monica Sjöö, who, in her book *The Great Cosmic Mother*, first published in 1985, declared that

we should know by now that human life engineered as an extension of a mechanoid vision is to the benefit of no one – except the owners of the machine. The industries and technologies of both Western capitalism and Soviet statism cannot exist without earth-rape, gross pollution of the environment, exterminations of vast numbers of animals and humans, of jungles and forests and grasslands, massive die-outs of terrestrial and oceanic life-forms – because systematic destruction is a function of the original patriarchal premise: exploit for power and profit. What can be done, under patriarchy, to one female body can be done, under world patriarchy, to the entire body of earth.

— ([Sjöö and Mor 1987](#b-9781474207935-028-0000183): 226)

She suggests that the man’s response to environmental catastrophe is to say “not to worry”, and to regale us with

his plans for a wholly programmed, artificial life. It will be such a great improvement over the natural life, which was so encumbered with mess and error. Grass will be replaced with astro-turf, hearts will be replaced with computers. On the market right now are fluffy, purring, meowing robot pussycats, which can do all the cute things real housecats can do (catch mice?) without the cost and bother. In fact everything can be replaced, including us, with those ‘good’, efficient, obedient, nonunionized, thoroughly dreamless machines.

— (ibid.)

She sees how

Moon and planets will become colonized resource stations; male and female astronauts, or the androids that replace them, will communicate with each other, with earthlings, and with galaxies in only the most linear, digitalized, and computational language. Regardless of their siliconic sophistication, the more humans rely on machines the more we become extensions of machines. The mechanoid processes meant to ‘free’ us are instead defining us.

— (ibid.)

Sjöö visited Greenham Common in 1982:

I took part in the marvelous action when 20,000 women surrounded the US missile base and decorated the fences with spider’s webs, baby rompers, photos of their grandmothers etc. … I was also involved with women for life on Earth. In 1985 Greenham women called women to a Walk across Salisbury Plane military firing ranges/MOD land in May. We, ca. 100 women, met at Silbury mound where we did a ritual and slept on Her belly in the near full moon light that night. For the next 2–3 days we walked the barren and desolate military land continuously threatened with imprisonment as we were followed by police. For some reason the police were always called off at the last minute from arresting us and we felt like an invincible army of sisters, who were somehow magically protected. Starhawk, the American witch, was on the walk and led rituals to centre and empower us.

— ([Sjöö n.d.](#b-9781474207935-028-0000181))

Perhaps the most important figure in this version of feminism was Starhawk (born Miriam Simos). Her book *The Spiral Dance*, published in 1979, was, and remains, one of the key texts for Goddess spirituality. In the book Starhawk proclaims that

On every full moon, rituals such as the one described above take place on hill-tops, on beaches, in open fields, and in ordinary houses. Writers, teachers, nurses, computer programmers, artists, lawyers, poets, plumbers, and auto mechanics – women and men from many backgrounds come together to celebrate the mysteries of the Triple Goddess of birth, love, and death, and of her Consort, the Hunter, who is Lord of the Dance of life. The religion they practice is called Witchcraft.

— ([Starhawk 1979](#b-9781474207935-028-0000186): 2)

Starhawk was a member of the Livermore Action Group, which opposed the nuclear-weapons research at the Livermore Laboratory in California. That Starhawk and others tried to use magic to combat the work of the Livermore Laboratory is more apt than might at first appear. As David Noble points out in his book *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, the Livermore Lab was one of the sites of the apocalyptic and transcendent culture made possible by the prospect of nuclear war. He quotes Robert Jay Lifton’s description of those working in such labs as “secular Armageddonists” ([Noble 1999](#b-9781474207935-028-0000160): 111). At Livermore a “tight-knit group of elite technologists was carefully assembled to carry on the spirit of the Manhattan Project. Isolated from the world by high security as well as by a peculiar set of customs, shared experience, and private language, theirs was ‘a very closed society’, akin to a monastery” (ibid.: 112).

## Feminism and Technology

As can be seen, for the 1960s generation of feminists technology was generally viewed as part of the apparatus of domination and control to which they were opposed. There were exceptions. Shulamith Firestone, for instance, saw technology as the means by which women could be freed from the burden of childbirth. Firestone, one of the most radical of her generation of feminists, developed a form of Marxist-oriented Feminism, in which she defined women as an oppressed group, in her terms a “sex-class”, and proclaimed the necessity of seizing the means of reproduction, of the species in this case, rather than of commodities. Firestone’s thinking in this regard anticipated more recent Feminist work about reproductive technology and science ([Firestone 1979](#b-9781474207935-028-0000135)).

At around the same time Constance Penley, who had already developed a reputation in film studies, began to look at science fiction and at the culture of technology. This resulted in the first case in the special edition of the Feminist film journal *Camera Obscura*, which was later published as a book, co-edited with Elisabeth Lyon, Lynne Spigel and Janet Bergstrom, entitled *Close Encounters: Film, Feminism and Science Fiction* ([Penley et al. 1991](#b-9781474207935-028-0000163)) and in the second in a book, co-edited with Andrew Ross, called *Technoculture* ([Penley and Ross 1991](#b-9781474207935-028-0000166)).

Penley’s and other feminists’ interest in science fiction reflected, in part at least, the degree to which Feminism had empowered women to make their mark in a previously male-dominated genre. The 1970s saw a generation of female SF writers come to prominence, including Ursula K. Le Guin, Anne McCaffrey, Joanna Russ, Kate Wilhelm, C. J. Cherryh and Joan Vinge, many of whom used the SF form to consider questions of gender and identity. (By comparison there were comparatively few female contributors to the SF genre known as cyberpunk, which emerged in the mid-1980s, the notable exception being Pat Cadigan. This is perhaps not surprising, given cyberpunk’s fascination with hardware and with the film noir form, with its solitary male hero.)

## The Cyborg Manifesto

It is in this context that Donna Haraway produced her famous Manifesto, inspired, in part at least, by female science fiction writers. In the Manifesto Haraway finds an alternative model for women’s identity in the figure of the cyborg, or cybernetic organism. This term, coined by engineer Manfred Clynes in 1960 and originally intended to denote the imbrication of man and machines, was derived from the work in the cybernetics of Norbert Wiener and others after the war.

Manfred Clynes and Nathan Kline’s paper in which the word “cyborg” first entered the English language was entitled “Cyborgs and Space”, and was published in the September 1960 issue of *Astronautics* journal. The abstract reads as follows: “Altering man’s bodily functions to meet the requirements of extraterrestrial environments would be more logical than providing an earthly environment for him in space … Artifact-organism systems which would extend man’s unconscious, self-regulatory controls are one possibility” (ibid.: 26). In a prefiguring of contemporary transhumanist rhetoric it suggests that “Space travel challenges mankind not only technologically but also spiritually, in that it invites man to take an active part in his own biological evolution”. Therefore the “task of adapting man’s body to any environment he may choose will be made easier by increased knowledge of homeostatic functioning, the cybernetic aspects of which are just beginning to be understood and investigated” (ibid.). It envisages the possibility of long-term space travel, lasting possibly several thousand years, one solution for which might be the “incorporation of integral exogenous devices to bring about the biological changes which might be necessary in man’s homeostatic mechanisms to allow him to live in space *qua natura*” (ibid.: 27). For this idea Clynes and Kline propose the term “cyborg”, from “cybernetic organism”. Thus the “purpose of the Cyborg, as well as his own homeostatic systems, is to provide an organizational system in which such robot-like problems are taken care of automatically and unconsciously, leaving man free to explore, to create, to think, and to feel” (ibid.). The authors cite experiments done on rabbits and rats in the administering of “continuous slow injections of biochemically active substances at a biological rate”. Clynes and Kline run through the potential problems that may arise in space travel and how their cyborg may help mitigate them, the most alarming of which are psychoses and what they call “limbo” (ibid.: 76). For the former they admit

there remains a strong possibility that somewhere in the course of a long space voyage a psychotic episode might occur, and this is one condition for which no servomechanism can be completely designed at the present time. While an emergency osmotic pump containing one of the high-potency phenothiazines together with reserpine could be a part of the complete space man’s kit, the frequent denial by an individual undergoing a psychotic episode that his thought processes, emotions, or behavior are abnormal, might keep him from voluntarily accepting medication. For this reason, if monitoring is adequate, provision should be made for triggering administration of the medication remotely from earth or by a companion if there is a crew on the vehicle.

— (ibid.)

Limbo is what they name their solution for extreme pain or suffering as a result of unforeseen accidents. “The astronaut should therefore be able to elect a state of unconsciousness if he feels it to be necessary. Prolonged sleep induced either pharmacologically or electronically seems the best solution”. They finish the article by suggesting that “Solving the many technological problems involved in manned space flight by adapting man to his environment, rather than vice versa, will not only mark a significant step forward in man’s scientific progress, but may well provide a new and larger dimension for man’s spirit as well” (ibid.).

The Manifesto itself starts with the claim that it is intended to “build an ironic political myth faithful to feminism, socialism, and materialism”, on the grounds that by the late part of the century we are all hybrids of the machinic and the organic, or in other words, all “cyborgs”. ([Haraway 1991](#b-9781474207935-028-0000149): 149). By acknowledging such an imbrication and its blurring of the distinction between human and machine the notion of the cyborg gets away from essentialist humanist concepts of women as childbearer and raiser, as well as those of individuality and individual wholeness, which are consonant with the heterosexual marriage and the nuclear family.

According to Haraway the “elementary units of socialist-feminist analysis”—race, gender and class—are in the process of transformation. The tools for analysis—Marxist, psychoanalytic, feminist, anthropological—are problematic as they are currently articulated. For Haraway Marxist humanism proposes that we can only come to know the subject through labour and relies on a Western self of self, which in turn erases “polyvocal, unassimilable, radical difference made visible in anti-colonial discourse and practice” (ibid.: 159). Psychoanalysis centres itself on the family and the drama of the birth of the self, and concomitant individuation and separation and the imagined loss of a wholeness before language. This is turn relies on the idea of woman as “other” and “in this plot women are imagined either better or worse off, but all agree they have less selfhood, weaker individuation, more fusion to the oral to Mother” (ibid.: 177). Psychoanalysis also universalizes its version of the human condition. In terms of Feminism there is nothing natural about being female that connects women, and, in fact, there is no such thing as being female at all (ibid.: 155). Feminism in the US has been characterized by the “natural” unity of all women, not taking into account, nor allowing room for, categories of race and class. Alternatively the danger is that of “lapsing into boundless difference and giving up on the confusing task of making partial, real connection” (ibid.: 160–61). Haraway argues that, in order to reconstruct socialist-feminist politics, it is necessary to address the “the social relations of science and technology, including crucially the systems of myth and meanings structuring our imagination” (ibid.: 163). She claims that there are dualisms that persist in Western culture, such as those of male and female, nature and culture, primitive and civilized (ibid.: 177). However, Haraway suggests that the new high-tech culture challenges such dualisms, as it is no longer clear what the relation between machine and maker is, and who or what makes the other. Above all there is no separation between machine and human, or between technical and organic (ibid.: 177–8).

As critics have pointed out the Manifesto is short on practical suggestions for living in an increasingly technological world, especially for women who are exploited by high-tech industries. Nevertheless cyborg theory has presented a powerful set of tools for women, and others, to engage positively with new technology without abandoning the radical promise of movements such as Feminism.

## Cyberfeminism

The Manifesto’s publication as part of Haraway’s collection of essays *Simians, Cyborgs and Women: The Reinvention of Nature* in the early 1990s coincided with the emergence of a new wave of feminist thought and action, which, after a moribund period in the 1980s, sought to reinvigorate the struggle from a number of different perspectives. The idea of identity and gender as constructs was an important part of poststructuralist and postmodernist thought, as well as for queer theory and for the liberal strain within feminism. Elements of the third wave did take up questions of community and identity in ways that resonated with the cyborg ideas of Haraway, and the emerging possibilities of electronic networked communication.

As the World Wide Web came to notice in the early to mid-1990s, it foregrounded the potential of electronic networks as public spaces in which identity and gender can remain fluid and indeterminate. One result of this was the emergence of so-called “cyberfeminism”, the name under which the work of a number of critical theorists and practitioners was corralled, and which denoted a shared concern with the utopian possibilities of new electronic media in relation to gender. Like Feminism cyberfeminism evades easy definition. It takes a number of different forms and encompasses disparate points of view.

Perhaps the most well-known expression of cyberfeminist theory, Sadie Plant’s book *Zeros + Ones*, presents a somewhat problematic, though poetically expressed vision of the relation between men, women and digital technology. Mixing together Freudian psychoanalytical theory and Freud’s own domestic history, with the history of computing, ranging from Ada Lovelace’s role in Babbage’s early experiments to Turing’s thought experiments and beyond, as well as cybernetics and biology, Plant presents a grand theory about the supposed resonances between the nature of computing and the rhizomatic qualities of female biology and female cultural practice:

*Just as individuated texts have become filaments of infinitely tangled webs, so the digital machines of the late twentieth century weave new networks from what were once isolated words, numbers, music, shapes, smells, tactile textures, architectures, and countless channels as yet unnamed. Media become interactive and hyperactive, the multiplicitous components of an immersive zone which ‘does not begin with writing; it is directly related rather to the weaving of elaborate figured silks.’ The yarn is neither metaphorical nor literal, but quite simply material, a gathering of threads which twist and turn through the history of computing, technology, the sciences and arts. In and out of the punched holes of automated looms, up and down through the ages of spinning and weaving, back and forth through the fabrication of fabrics, shuttles and looms, cotton and silk, canvas and paper, brushes and pens, typewriters, carriages, telephone wires, synthetic fibers, electrical filaments, silicon strands, fiber-optic cables, pixeled screens, telecom lines, the World Wide Web, the Net, and matrices to come.*

— ([Plant 1997](#b-9781474207935-028-0000175): 11–12)

In her 2004 book *Technofeminism* Judy Wajcman took Plant and other cyberfeminists to task for what she saw as a failure to understand women’s actual relation to technology. She suggests that, with the stalling of space travel, “Cyberspace, virtual reality and the Internet have taken over as the new frontiers for exploration and transcendence”, so it is “little wonder that feminists have seized upon new digital technologies for their potential to finally free women from the constraints of their sex” ([2004](#b-9781474207935-028-0000194): 42). For Wajcman Plant’s

*mélange* of postmodern/French feminist/psychoanalytic theories of the fractured identities of woman, with sets of embodiments, might have led her to emphasize the differences between, as well as within, individuals. However, she does not connect these theories on multiple identities and bodies with the multiple lived experiences that give rise to them. Rather, throughout Plant’s analysis there is dissonance between her appeal to universal feminine attributes and her conceptualization of women’s fragmented identities.

— (ibid.: 52)

Above all Plant fails to acknowledge that

for most women, however, their main encounter with computers is in the workplace. Computing remains a very male industry, with women having limited career prospects in the information technology, electronics and communications sectors. More broadly, the shift to the information or knowledge economy has been marked by an enormous growth of contingent workers, with women making up the majority of part-time and temporary workers. This increase in flexible work could not have occurred without the proliferation of the information and communications technologies that support it.

— (ibid.: 52–3)

Thus

Technology itself replaces the need for programmes of social and political change. The very value of utopian thinking is undermined. Its value is precisely to create a space between contemporary experience and political desires, and to turn them optimistically towards the construction of new forms of politics. This has always been the project of feminism, and was one of the reasons for its hostility towards deterministic social theories. The underlying critique holds good even when what is determined is said to be in the interests of women. It would be unwise to presume that the direction of technological change has simply changed sides to benefit women where once it benefited men.

— (ibid.: 53)

## Conclusion

This brings us back to Greenham Common. Iris Marion Young suggests that

Creative civil disobedience actions wove webs of yarn at entrances to the Pentagon and set up colorful camps on cruise missile sites in England’s Greenham Common. Writings of the women’s peace movement tried to make theoretical connections between male domination and militarism, between masculine gender and the propensity to settle conflicts with violence, and these echoed some of the voices of the women’s peace movement earlier in the twentieth century. By the early 1990s the humor and heroism of the women’s peace actions had been all but forgotten.

— ([Young 2007](#b-9781474207935-028-0000202): 115)

At first glance the Manifesto appears to be operating in a very different world to that of the spiritual concerns of the Greenham Common protestors. As Joan Haran puts it this

assumed polarization emerges from a series of rhetorical moves in academic feminism that relegated feminist essentialism (attributed to radical feminists and ecofeminists) to the 1970s with putatively more sophisticated post-structuralist feminist theory ascendant in the 1980s and 1990s – moves that manifested a dualism which both ecofeminists and Haraway critiqued. Through this lens, Haraway was assigned to the theoretically sophisticated camp, and Starhawk consigned to the camp of unsophisticated essentialism.

— ([Haran 2019](#b-9781474207935-028-0000144): 428)

Yet, as Anna [Feigenbaum (2015)](#b-9781474207935-028-0000130) points out, the fact that the Manifesto was directly inspired by women’s anti-nuclear activism in which Starhawk’s form of Goddess spirituality thrived has been largely forgotten, even though this inspiration is explicitly acknowledged in the text itself. Writing about the tendency already evident in the 1980s towards miniaturization Haraway discusses the new portable technologies of television and video ([1991](#b-9781474207935-028-0000149): 153).

These new machines “are floating signifiers moving in pickup trucks across Europe, blocked more effectively by the witchweavings of the displaced and so unnatural women of the antinuclear Greenham Women’s Peace Camp, who read the cyborg webs of power so very well, than by the militant labor of older masculinist politics, whose natural constituency needs defense jobs” (ibid.). In the text she also cites “spiral dancing in Sant Rita jail”, which, in a footnote to at least one version of the Manifesto, she describes as a “practice at once both spiritual and political that linked guards and arrested anti-nuclear demonstrators in the Alameda County jail in the early 1990s” (ibid.: 154). She also cites the “LAG, the Livermore Action Group, as a kind of cyborg society, dedicated to realistically converting the laboratories that most fiercely embody and spew out the tools of technological apocalypse, and committed to building a political form that actually manages to hold together witches, engineers, elders, perverts, Christians, mothers, and Leninists long enough to disarm the state” (ibid.: 154–5). Starhawk was a member of the LAG. This too is followed by an endnote:

Without explicit irony, adopting the spaceship earth/whole earth logo of the planet photographed from space, set off by the slogan ‘Love Your Mother’, the May 1987 Mothers and Others Day action at the nuclear weapons testing facility in Nevada none the less took account of the tragic contradictions of views of the earth. Demonstrators applied for official permits to be on the land from officers of the Western Shoshone tribe, whose territory was invaded by the US government when it built the nuclear weapons test ground in the 1950s. Arrested for trespassing, the demonstrators argued that the police and weapons facility personnel, without authorization from the proper officials, were the trespassers. One affinity group at the women’s action called themselves the Surrogate Others; and in solidarity with the creatures forced to tunnel in the same ground with the bomb, they enacted a cyborgian emergence from the constructed body of a large, non-heterosexual desert worm.

— (ibid.: 245)

Feigenbaum aims to “turn back to Western feminists” 1980s anti-nuclear activisms’, and to “map out an activist history of feminist cyborg figures, examining how women in the antinuclear movement combined affect and techné, creating innovative images of, and tactics for, resistance to militarism” ([Feigenbaum 2015](#b-9781474207935-028-0000130): 269). She suggests that “Protest camps often become ‘laboratories of innovation’, convergence sites at which different ideologies and experiences intermix, yielding new tactical repertoires” (ibid.). In particular “from the place of the protest camp, Greenham women’s ‘cyborg writing’ arose through their material entanglements with the technologies and environments of the military base”. She suggests that “women’s creative symbolic practices and their use of tools challenged the dichotomous constructions of women peace activists” relations to technology, such as the binaries of nature/technology, organism/machine and human/animal’ (ibid.: 269–70). This returns her “to the anti-nuclear activisms at the heart of Donna Haraway’s feminist cyborg” to show “how Greenham women interwove symbolic attributes culled from both goddess and cyborg imaginaries, developing figures such as Cybil the snake and the ‘metal Goddess’”(ibid.: 270). Thus “Greenham women’s ‘materialsemiotic practices’ were manifested in particular engagements between bodies and objects that re-imagined feminist subjectivities and reoriented the meanings and uses of technologies” (ibid.). However:

As ‘Haraway’ became synonymous with ‘the feminist cyborg’, both the nuance and subjects of Haraway’s original analysis were frequently lost. The cyborg was attributed (or filled up) with a variety of new meanings that at times bear little resemblance to Haraway’s work. As the feminist cyborg moved through various disciplinary iterations, its political context and content were often not referenced.

— (ibid.: 271)

Haraway’s declaration that she would rather be a cyborg than a goddess is followed by “though both are bound in the spiral dance”, a clear invocation of Starhawk’s most famous work. She returns to this figure of the Spiral Dance in her “Camille Stories: Children of Compost” in her 2016 book *Staying with the Trouble: Making Kin in the Chthulucene*. These recount the stories of five generations of children named Camille, who live in symbiotic relations with their animal others, over a period of four hundred years. The first is born in 2025, and the last dies in 2425. It is she, Camille 5, who becomes a “Speaker for the Dead”, who are taught Starhawk’s song from her book *Truth or Dare*. The poem starts “Breathe deep/Feel the pain” ([Haraway 2016](#b-9781474207935-028-0000152): 166). Haraway suggests that

The Speakers for the Dead are also tasked with bringing into mind and heart the new things of earth, not only the symbionts and symanimants and their communities and corridors, but also the emerging kinds of beings and ways of life of an always evolving home world. The Speakers for the Dead seek and release the energies of the past, present, and future Chthulucene, with its myriad tentacles of opportunistic, dangerous, and generative sympoiesis. The Children of Compost would not cease the layered, curious practice of becoming-with others for a habitable, flourishing world.

— (ibid.: 168)

Haraway and Starhawk met at a colloquium organized in 2017 by Joan Haran at the University of California Santa Cruz, entitled “Imaginactivism: A Public Conversation with Donna Haraway and Starhawk: Magic, Figuration and Speculative Fiction as Calls to Action”. At the meeting, according to Haran, Haraway “stressed that although she remained allergic to the language of the sacred, she recognized that her affirmation of ‘mortality and finitude’ and ‘that the living and dying and flourishing with each other is worth living and dying for’ fundamentally converges with what Starhawk would call the sacred” ([Haran 2019](#b-9781474207935-028-0000144): 438).

The Belgian philosopher of science Isabelle Stengers seems prepared to go where Haraway will not—in embracing the work of Starhawk and its implications. Stengers is a trained scientist, like Haraway. In *Capitalist Sorcery*, the book she wrote with Philippe Pignarre.

There has, for a long time, been a name for something that manages to produce a coincidence between enslavement, the putting into service, and subjection, the production of those who do freely what they are meant to do. It is something whose frightening power and the need to cultivate appropriate means of protection against is known by the most diverse of peoples, except us moderns. Its name is sorcery.

— ([Pignarre and Stengers 2011](#b-9781474207935-028-0000172): 35)

In naming capitalism thus, Stengers and Pignarre are able to invoke what they see as a means of resistance, magic:

The word ‘magic’ is one of those words. As the neo-pagan witch Starhawk writes ‘to utter the word “magic” is already an act of magic: the word puts to the test, compromises, exposes to sniggering. It forces us to feel what it is in us that balks and which is, perhaps, precisely what renders us vulnerable to capture’. That is why we have decided to expose our readers to a last test, and in the process expose ourselves too: to try to take seriously those Americans who have dubbed themselves ‘neo-pagan witches’ and have cultivated the heritage of techniques of non-violent action in a mode that combines ‘resisting capture’ and ‘learning to give thanks’.

— (ibid.: 134)

The recent rise of interest in witchcraft, in response to the political chaos of the last few years, can be seen as a kind of dialectical sublation of the binary opposition of cyborg and goddess/witch, taking place in the context of a digitally saturated culture. For example the writer Linda Stupart, whose work *Virus* includes spells against the patriarchy, proclaims, when asked about Haraway’s Manifesto:

That essay is so amazing. What Haraway gives is a more complex idea about gender, one that got picked up and popularised by cyberfeminism in the 1990s. When you go back to that essay, it’s so queer. There is so much to take from the cyberfeminists, whose work is drawn from a powerful concoction of rage and optimism. But it’s often rooted in what seems like an inherent womanhood or femininity, and I’m interested in harnessing those forces and putting them through a queer and gender-queer prism.

— ([Studio International 2017](#b-9781474207935-028-0000189))

Writing about Suzanne Treister’s Hexen 2:0 Multimedia Project, involving Tarot cards featuring figures from the history of cybernetics, Andrew Pickering suggests that Treister is “doing a Haraway, showing us the centrality of cybernetics to postwar history, and also points to the degree to which the pioneers of cybernetic thinking were also deeply involved in the occult” ([Pickering 2012](#b-9781474207935-028-0000169)). Perhaps most exemplary of this sublation is the work of the “New Mystics”, “a platform for collaboratively exploring the interconnections of magic and technology. It features both human and non-human voices, with texts co-authored by the Language AI GPT-3”:

When engaged with magic, technology can serve as a generative portal between world-as-is and worlds-yet-to-come; in Donna Haraway’s terms, it can foster a way of ‘becoming with’ a world in which ‘natures, cultures, subjects and objects do not pre-exist their intertwined worldings.’ New Mystics brings these expanded practices together – learning from AI poetics, lost folklores, indigenous knowledge systems, plant healing, psychedelics, science fiction, interstellar shamanism, and non-human intelligence, among other sources – to speculate on worlds filled with magic.

— (New Mystics, [<www.newmystics.xyz/cccccccccc>](www.newmystics.xyz/cccccccccc))

Amy Hale’s 2022 article “Communist Witches and Cyborg Magic: The Emergence of Queer, Feminist, Esoteric Futurism” for *Burlington Contemporary* claims that

The persistent relevance of Haraway dominates the theoretical fabric of these artists, with influences ranging from the abiding *Cyborg Manifesto* (1985) to *Staying with the Trouble* ([2016](#b-9781474207935-028-0000152)). Haraway emphasises the planetary condition of various enmeshments – with technology, non-human animals and plants – breaking down conceptual and physical essentialisms, promoting an ethos of care and mutuality, what she refers to as the entwinement that emerges from ‘tentacular thinking’. Haraway’s conception of ‘feminist speculative fabulation’ resounds with relevance in characterising these artists: ‘It matters what stories make worlds, what worlds make stories’.

— ([Hale 2022](#b-9781474207935-028-0000141))

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# Back matter

## List of Contributors

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*Joseph Nechvatal* is an American transdisciplinary artist, theoretician/philosopher, art critic, writer and audio artist. Focusing on virus-modelled artificial life computer-assisted paintings and digital animations, his work has addressed issues as diverse as the apocalyptic, communication excess, the virus and gender fluidity. His PhD is in the philosophy of aesthetics and technology. His best-known art theory book is *Immersion into Noise* (2011).

*Linda O’Keeffe*, Professor of Art at Stony Brook University, New York, is a sound artist and advocate for women in the sonic arts, founding the Women in Sound Women on Sound (WISWOS) and editing the *Interference Journal* (2012–22). Her cross-disciplinary work at the intersection of art, science, technology and community has resulted in a number of impactful artworks and collaborations. She co-edited the book *The Body in Sound, Music, and Performance* (2022) and was president of the Irish Sound, Science and Technology Association from 2015 to 2017, enriching dialogues around research and sonic arts practices.

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## Acknowledgements

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*Luke Skrebowski:* the article in this encyclopedia draws on my prior work on Burnham (as noted in my list of references) and includes material from my previously published article: Luke Skrebowski, “Jack Burnham Redux: The Obsolete in Reverse?”, *Grey Room*, 65 (Fall 2016): 88–113. © 2017 by Grey Room, Inc. and the Massachusetts Institute of Technology, published by the MIT Press.

## List of Illustrations

### Black and White Illustrations

#### **Article 2. Museums and Galleries, *Beryl Graham***

[2.1](#b-9781474207935-002-0000020) *Uterus Man* game on kiosk (2013) by Lu Yang. Installation, Lu Yang: “Encephalon Heaven” exhibition, M Woods Gallery, Beijing, October 28, 2017–February 11, 2018. Photograph by Beryl Graham. Image courtesy of Lu Yang. (SEE COLOUR PLATES SECTION.)

[2.2](#b-9781474207935-002-0000034) Screenshot from *Naked on Pluto* website (2012) by Aymeric Mansoux, Marloes de Valk and Dave Griffiths. Image courtesy of Aymeric Mansoux. (SEE COLOUR PLATES SECTION.)

[2.3](#b-9781474207935-002-0000060) *Pulse Room* (2010) by Rafael Lozano-Hemmer. Installation view from an exhibition at Manchester Art Gallery, Manchester, UK. Photograph by Peter Mallet. Image courtesy of Rafael Lozano Hemmer. (SEE COLOUR PLATES SECTION.)

[2.4](#b-9781474207935-002-0000081) Installation view of the Nam June Paik Library at the Nam June Paik Art Center, Seoul. Designed by Nahyun Hwang and David Eugin Moon (NHDM). Image courtesy of Nam June Paik Art Center.

[2.5](#b-9781474207935-002-0000104) Daniel Brown’s generative software work *Tropic of Sunderland* 2008. Installed on the exterior of Sunderland Aquatic Centre. Photograph by Colin Davison. Image courtesy of Daniel Brown and NGCA.

[2.6](#b-9781474207935-002-0000110) *Psalms* (1997) by Donald Rodney with the University of Plymouth. Installation shot from the exhibition “Reimaging Donald Rodney” by Ian Sergeant (curator) and Yasmeen Baig-Clifford (producer), 7 October–November 5, 2016. Birmingham: Vivid Projects. Photograph by Beryl Graham. Courtesy of Vivid Projects and Estate of Donald Rodney.

[2.7](#b-9781474207935-002-0000120) Screenshot details from *MulengaMoji* (2016) by Emily Mulenga. Screenshot courtesy of Beryl Graham.

[2.8](#b-9781474207935-002-0000125) Bager Akbay, Deniz Yilmaz (2015–). Installation shot of writing machine. Image courtesy of Aydin Bager Akbay.

#### **3. Art Education, *Catherine Mason***

[3.1](#b-9781474207935-003-0000023) *Hummingbird* by Charles Csuri (1967). Still from 16mm film transferred to video (black and white), 12 min. The Museum of Modern Art, New York. Purchase, 1969. © 2017 Charles Csuri. Photograph courtesy of Charles Csuri and CsuriVision ltd.

[3.2](#b-9781474207935-003-0000030) *QUAD 1, the Maquette* by Robert Mallary (1968). Plastic. Photograph courtesy of Estate of Robert Mallary. (SEE COLOUR PLATES SECTION.)

[3.3](#b-9781474207935-003-0000039) *Wheels1* by Roger Saunders (1973). Computer printout. Courtesy of Roger Saunders. Saunders received a copy of *Art1* from Katherine Nash and used it as a nucleus to develop his final-year project at Brighton Polytechnic—a program called PLAD1 (Program Language for Art and Design).

[3.4](#b-9781474207935-003-0000045) “CIRCUIT” announcement designed by Lillian M Quirke from *PAGE 30* (1973). Courtesy of the Computer Arts Society.

[3.5](#b-9781474207935-003-0000054) Johannes Itten, plan of the Basic Course training program at the Weimar Bauhaus. Engineering and science are the core around which all other studies are built. © DACS 2023.

[3.6](#b-9781474207935-003-0000066) Photograph of the Slade School of Art computer studio showing Dominic Boreham at work, 1977. © Estate of Dominic Boreham. Courtesy of GV ART London.

[3.7](#b-9781474207935-003-0000074) *Untitled* (undated circa 1977) by Harold Cohen. Courtesy of Harold Cohen Estate and Gazelli Art House. Collection of Brian Reffin Smith.

[3.8](#b-9781474207935-003-0000080) Cover of 1983 Penguin edition *The Soul of a New Machine* by Tracy Kidder, featuring a photograph by Nigel Grierson depicting artist Jeremy Gardiner and colleague working in the Department of Design Research at the Royal College of Art.

[3.9](#b-9781474207935-003-0000096) *M3x3* (1973) by Analívia Cordeiro. Still. Courtesy of Analívia Cordeiro.

#### **4. Mathematics, *Ernest Edmonds***

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[6.5](#b-9781474207935-006-0000081) (a), (b), (c): *Everyone’s Photos Any License (654 of 1,146,034 Full Moons on Flickr, November 2015)* (2015). Digital C-prints, 104 x 324 in. (264 x 822 cm); corresponding attribution map and list, 11” x 17” laser print and 6” x 9” perfect bound booklet. Courtesy of Penelope Umbrico and the Milwaukee Art Museum.

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