The New Media Reader

Edited by
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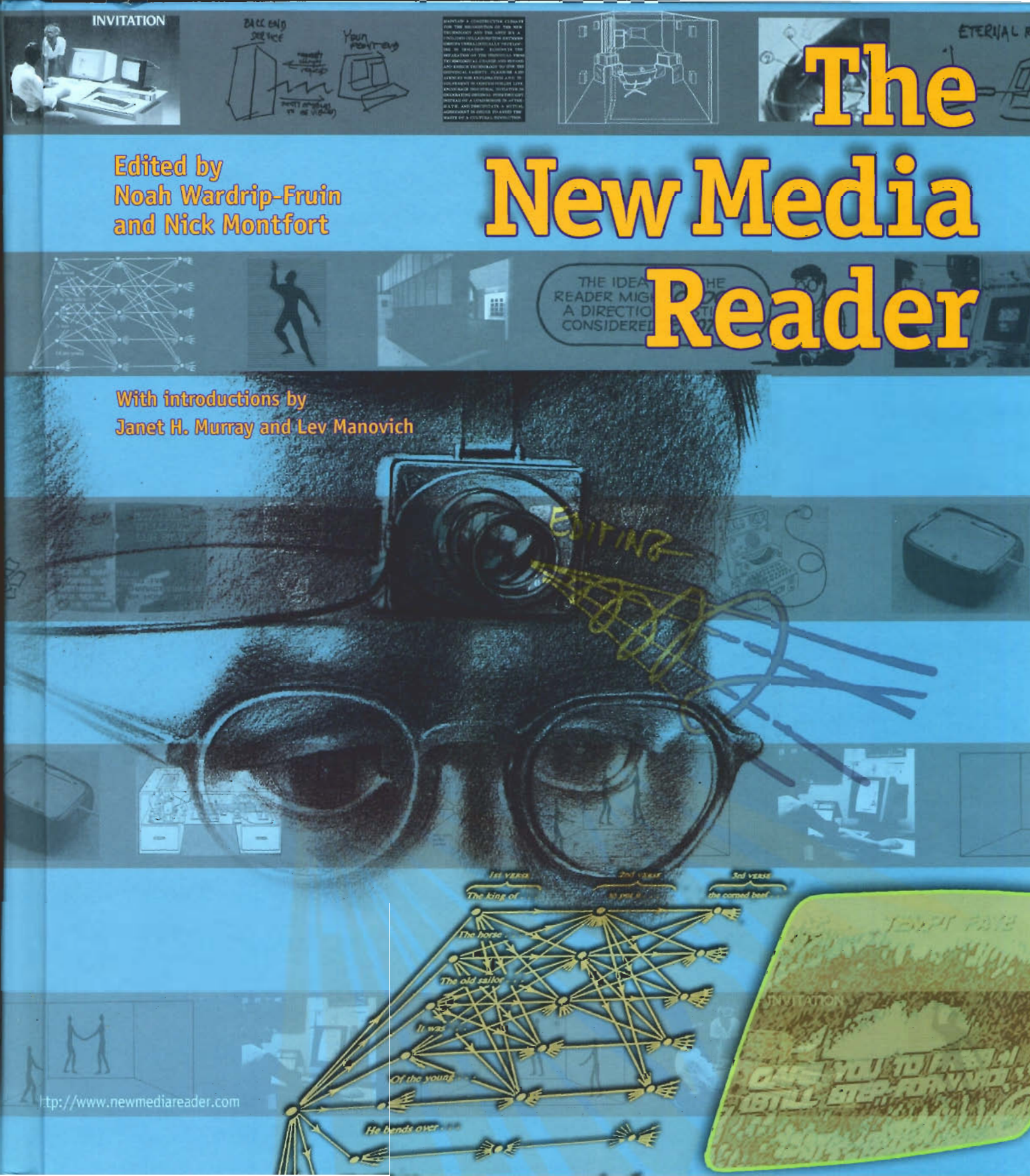
With introductions by
Janet H. Murray and Lev Manovich



theNewMediaReader

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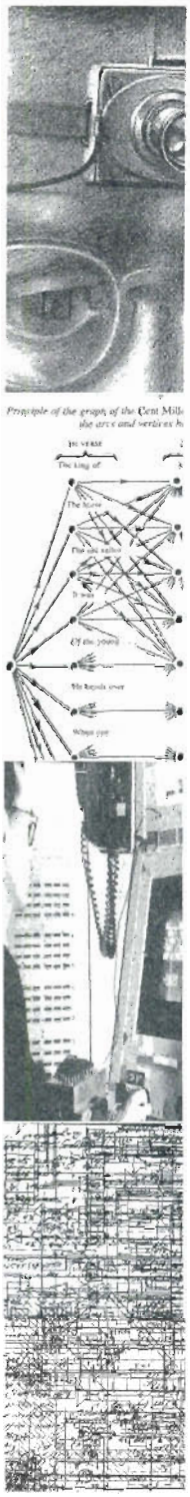

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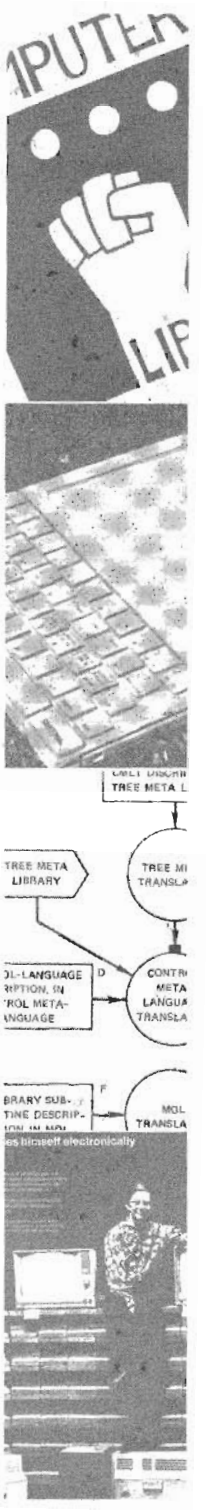

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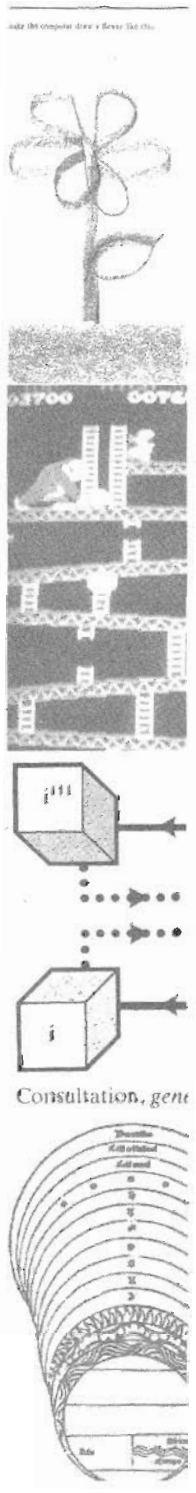

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Inventing the Medium

Janet H. Murray

This is a landmark volume, marking the first comprehensive effort at establishing the genealogy of the computer as an expressive medium.

Although the name of the book is *The New Media Reader,* its subject is the emergence of a single medium, and one which we can define more particularly than by merely by pointing to its novelty. The *digital medium* which we see emerging in these well-selected and contextualized essays may seem plural to us now, because it is so myriad in its forms—virtual reality CAVEs, the Internet, "enhanced" television, videogames. Indeed, like the medium of film 100 years earlier, the computer medium is drawing on many antecedents and spawning a variety of formats. But the term "new media" is a sign of our current confusion about where these efforts are leading and our breathlessness at the pace of change, particularly in the last two decades of the 20th century. How long will it take before we see the gift for what it is—a single new medium of representation, the digital medium, formed by the braided interplay of technical invention and cultural expression at the end of the 20th century? This reader, reflecting the burgeoning of "New Media Studies" throughout academic life and new media practice throughout the world, should help to hasten that change in our thinking.

Here for the first time within a single volume we can trace the cultural helix, the echoing and opposing strands that form the DNA for cyberspace itself. The first two essays establish the pattern, a call and response of fantasist and engineer, philosopher and inventor. Borges (◊01), the storyteller-librarian, and Bush (◊02), the soldier-scientist, speak to us out of the same midcentury frame of mind, exhausted by war, exhilarated by a dawning sense of globalism. They are both almost viscerally aware of the increased complexity of human consciousness and the failure of linear media to capture the structures of our thought. Borges, one of the first fiction writers to place himself in the expanded context of a global culture, is fascinated by the arbitrariness of language itself, by the flutter of meaning across cultural boundaries. His fiction evokes a sense of flickering focus, of an individual consciousness constantly reforming itself, of an utterance constantly in the process of translation. Borges confronts us with the "pullulating" moment, when we become aware of all the possible choices we might make, all the ways in which we might intersect one another for good or evil. His imagined Garden of Forking Paths is both a book and landscape, a book that has the shape of a labyrinth that folds back upon itself in infinite regression. It is a dizzying vision, one which will be described again by humanist writers for the rest of the century.

For Vannevar Bush, the scientist, the world is not an imprisoning labyrinth, but a challenging maze, waiting to be solved by an appropriately organized and clever team effort. Like Borges, Bush imagines alternate libraries. But where Borges's visions are playful and subversive of rationalist exploration, Bush dreams of the hyperrational. He is alarmed to discover that the library shelf is no longer an adequate map of knowledge. Book-based organizational structures have been outpaced by the tempo of investigation, and no longer reflect the constantly reformulating disciplinary boundaries of contemporary scholarship. Knowledge is expanding, but human life remains too short. Where Borges is frozen at the crossroads, enraptured by the proliferating paths, Bush is impatiently searching for the shortcuts, the paths forged by the experts who have scouted the territory before us. He wants to follow in their footsteps and to lay down new trails, trails that do not fade. His engineer's commitment to the redemptive machine runs throughout this volume as well.

Bush, of course, is not thinking about the "computer"—and neither is Borges. Instead they are inventing fantasy information structures—a book-garden-maze, a desk-library-machine—that reflect not a new technology but a change in how our minds are working. The change they imagine is made more urgent by the experience of two world wars, wars that made apparent the huge gulf between our technological prowess and our social development, between our complex thinking and our atavistic behavior. In Borges's fable, the protagonist kills a man as a form of information processing, the murdered man being significant only because his name in the newspaper will act as an appropriate coded message.

Bush's example of a representative research subject is the history of bow and arrow technology. He has learned the power of information organization in the context of wartime weapons development, where more knowledge means more power against the enemy.

Central to Borges's story is our discomfort over the narrator's amoral choice, the impersonal, political murder of a man who in alternate "forks" becomes his friend. There is no right side in his warscape; the murderer does not believe in his cause or care which side wins. In the world of the forking path garden, time does not move forward at all, but outward in proliferating possibilities of creation and destruction that make up the totality of human potential. To live in Borges's world is to feel complicity and exhaustion, but also wonder. Bush's view, on the other hand, is moralistic, energetic, and engaged. Implicit in Bush's narrative is the Enlightenment faith in human progress driven by expanded knowledge, the American metaphor of the rich frontier waiting to be conquered by the able trailblazer, the absolute necessity of self-defense. Bush's maze challenges us, but we are smart enough to find our way out. The solution lies in building something, in making something new that will better serve human need. This dichotomy runs through the rest of the century and is echoed throughout this anthology.

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All creativity can be understood as taking in the world as a problem. The problem that preoccupies all of the authors in this volume is the pullulating consciousness that is the direct result of 500 years of print culture. One can think of the humanist strand as dramatizing the problem, amplifying our discomfort by denaturalizing the rituals by which we deny it. The disciplinary humanists in this volume, whether artists, theorists, or scholars, are all engaged in foregrounding our cultural confusions, tuning up our sense of existential befuddlement before the scientifically revealed world of the twentieth century. The engineers, on the other hand, put their faith in the invention of the proper instruments, that, like the microscope and telescope before them, will let us focus on the things that baffle and unhinge us so that we can think about them in a systematic way. The right instruments organize not just the outer world but consciousness itself, a phenomenon that is feared by the humanists and embraced by the engineers. The engineers see the central task of our time—finding the key to survival in the atomic age—as a challenge to our intellects. The world has become more difficult to understand, so we need better ways of thinking about it, more powerful methods of mastering complexity. The library shelf and the chaptered book create both overview and close-up and allow us to move between them without losing our place. What the computer offers us is a more capacious shelf, a finer grained division. The engineers articulate a vision of a new meta-book, a navigable collection of books that will carry us gracefully to the next level of information control and systematic thought, just as the invention of print did 500 years ago. The humanist voices in this survey start off at a greater distance from the material basis of the new medium, and they are often much less hopeful. They find the punch cards of the early information age of little use. They are surveying the wreck of ideologies, coming to terms with the failed promises of print, the horrifying trajectory of the rationalist arrow. They insist that we experience the flickering focus, the slipping away of meaning between the signifier and the signified, that is the intellectual predicament of the second half of the twentieth century.

The authors in this volume line up on both sides of this divide, but they are also facing one another along the braided path. The difference is not so much in what they describe as in their orientation to it. The humanists see the contradictions and limitations of the great systems of thought and it causes them to question the very project of systemized thinking. Such questioning is of their moment but it also is part of a longer tradition of literary and philosophical discourse that articulates the unknowability of life, its tragic dimension, and the absurd and maddening persistence of longing, suffering, need.

The engineers are grounded in a tradition that emphasizes solution and defines the needs it cannot satisfy—and the suffering its solutions can inflict—as outside the domain of the problem. At its worst, the engineering mentality creates efficient killing machines, faster and more deadly arrows. It exults in the ability to "Put-That-There" (◊29), to move weapons around a map with the flick of a magically gloved finger. At its best, it fosters the comic view of the world in which we are resilient enough to problem-solve our way out of our troubles up to the very barrier of mortality itself. At its best, it also celebrates the human capacity to learn and to conceive things that had not been thought of before, things that might make us not just smarter but more creative.

The strands cross one another throughout the period that this anthology delineates, and a single individual often seems to straddle the gap between them. The engineers draw upon cultural metaphors and analogies to express the magnitude of the change, the shape of the as yet unseen medium. The storytellers and theorists build imaginary landscapes of information, writing stories and essays that later become blueprints for actual systems. The engineers pace themselves against an accelerating threat of annihilation by the new war technologies; the humanists imagine the machine as a redemptive environment, welcoming the prospect of cyborg architectures that reconfigure our bodies, our cultures, our selves in hopeful ways. The two traditions come together most energetically in collaborations focused on new structures of learning in which exploration of the computer is motivated by a desire to foster the exploratory processes of the mind itself. Gradually, the braided collaboration gives rise to an emergent form, a new medium of human expression.

By bringing these two strands together in this chronologically arranged collection, the editors invite us to look more closely at the rich interplay of cultural practice and technical innovation. We see the scientific culture articulating a medium that "augments" our humanity, that makes us smarter by pooling our thinking and organizing it at a higher level, and even by facilitating new ways of thinking that are more synthetic and have more power to master complex operations and ideas. Meanwhile the arts are engaged in dicing the language and recombining it randomly, calling attention to the arbitrary nature of the written and spoken signifiers, dramatizing the sense of cultural unraveling after two world wars. Seeing all of these players gathered within the boundaries of this one volume we can almost imagine them in a single room, participating in a kind of quilting bee. In one corner, Borges (◊01), Burroughs (◊07), and the Oulipo (◊12) are busy shredding the outgrown garments of print, while across the room Bush (◊02), Engelbart (◊08, ◊16), and the Xerox PARC collaborators (◊26) are eagerly sewing the fragments together into an intricately patterned, vast, and welcoming quilt. The process begins in mid-century, with the earliest understanding by Turing (◊03), Wiener (◊04), and others of the potential of the computer for symbolic representation and for the capturing of complex interactive systems.

Computer languages were developed that allowed for more powerful manipulation of quantitative and text-based data, supporting large databases, scientific and economic simulations, and research in artificial intelligence. The 1960s were a time of dizzying progress for computer scientists, the period in which the field itself was defined, separated from electrical engineering and mathematics with its own advanced degree programs. It was the time when Licklider (◊05) and others were proposing the Internet, when Weizenbaum (◊24) inadvertently invented the first believable computer-based character, when Nelson (◊11, ◊21, ◊30) coined the word "hypertext" and began his lifelong quest to embody it.

And it was the time when Douglas Englebart, looking about him and seeing that the human race was "in trouble," committed his career to the "augmenting of human intellect." Had Englebart been given the resources to realize more of his "Framework," he might have been the prolific Michaelangelo of the computer renaissance, demonstrating how to do many difficult things with maximum expressivity. As it was, he has been a kind of Leonardo, accomplishing much, indirectly influencing much, but leaving behind the unrealized plans for even more. Englebart did not think of the computer as merely improving human thinking, but as transforming the processes of our institutions in a more profound way. The "augmented institution" as he saw it would change not into a "bigger and faster snail" but would become a new species, like a cat, with new sensory abilities and entirely new powers. The evolutionary metaphor is an expression of awe at the magnitude of the shift, a way of sharing the shiver of terror at the unfamiliar rush of mind-power that makes us wonder if we might be capable of outthinking our very humanity.

By the end of the 1960s the engineers had a good understanding of the potential of the computer. They were supporting large databases, experimenting with on-screen images and game-like interaction, establishing networked systems that could be accessed by remote terminals with multiple users sharing the same mainframe, and building large-scale simulation systems. Although the machines themselves were slow and of little capacity by current standards, and were primarily used for number crunching,

they had been developed well enough to make concrete Turing's vision of a universal machine. A decade before the development of "multimedia" and at the point when "hypertext" was just a concept, the sheer representational power of the computer was apparent to those who were leading its development. They realized that the whole of the medium was much more than the sum of the various enabling technologies.

As I have argued elsewhere, the awe-inspiring representational power of the computer derives from its four defining qualities: its procedural, participatory, encyclopedic, and spatial properties. The most obvious property of the new medium, the one most clearly needed by the post-war world, was its encyclopedic capacity. The digital computer is simply the largest medium human beings have ever invented, the one capable of holding the most information. In the 1960s much of that memory was on tape or punch cards, and dependent on linear reading. In the succeeding decades it reached dizzying thresholds of random access availability, with exponential increases becoming the norm. But the deeper encyclopedic potential of binary representation itself was clear from Turing's time. If the computer is a universal machine, capable of representing anything, then can it represent all of human knowledge? Like other capacious technologies (print, moving images) which the computer contains, it calls forth our desire to get everything in one place, to get, as William Faulkner once described the aspiration of the novelist, the whole world in one sentence.

Furthermore, the computer can present itself to us as a place, one which we enter and do not wish to leave. This enveloping quality derives from the spatial property of the medium, its capability for embodying dimensionality. That is, we can place things within it in assigned locations, both actual (as registers within the machines) and, more importantly, symbolic (as on a Web "site," or in a dungeon under a trap door within a fantasy environment). These locations are more than merely labels because we can navigate by them, and they will be consistent relative to one another. This spatial quality made the early text-based dungeon games like *Adventure* ⊗ and *Zork* enormously successful. This spatializing quality is based upon the other two properties of the digital medium, the two most basic and defining attributes: its processing power, which allows us to specify procedures which will be not merely recorded but executed; and its participatory quality, which allows it to receive input, to allow manipulation of its processes and data by the user. The creation of the illusion of space within the machine, which can be achieved with only a text-based display, is the result of its capacity for accepting navigational commands from us and then responding according to its programming in a consistent manner that reinforces our notion of space. That is, we can program the responses of the computer to simulate any space we can imagine, displaying "north" and "south" or "left" and "right" appropriately so that the participating user will form a reliable mental map of the symbolically represented territory. But even though this "spatial" property is derivative of the procedural and participatory properties, it is so fundamental to the way we experience the world, and so desirable a means of representing the world, that we have to think about it as a property in itself. It is not accidental that we refer to information in digital networks as existing in "cyberspace," or that the first computer game to be massively distributed by network was a text-based exploration of a virtual cave.

Together the two properties of encyclopedic capacity and spatial navigability create the experience of enclosure in explorable, extensive spaces. These can be fictional landscapes, like Borges's labyrinthine garden, or they can be information spaces, like Bush's memex machine. The sense of following a trail is the same in both cases, and it is a sense that creates the pleasurable experience of immersion, of moving within a capacious, consistent, enveloping digital environment rather than just looking at it.

But the more fundamental properties, the procedural and participatory foundation of the computer, are the ones that provide the basis for what we think of as the defining experience of the digital medium, its "interactivity." Although this word is often used loosely it can be thought of as encompassing these two properties, and also the pleasure of agency, the sense of participating in a world that responds coherently to our participation. We do something with the computer—whether it is shooting at a fantasy enemy or manipulating words or images or moving from one Web site to another—and it processes our input and responds in a way that makes sense to us. Because of the interactive nature of the medium, the computer environment is not just

immersive, it is animated. This effect was clear from the introduction of the computer workstation in the 1960s, when the new conversational structure of programmer and processor, keyboard and display, connected in real time provoked playful applications like the therapist Eliza ⊗ or the dungeon and dragon of *Adventure* ⊗. Both of these inventions took advantage of the streamlined interactivity of the new environments. They elicited engagement from an interactor, and they responded to that engagement in a way that made clear the animating rules of the computer's world.

The invention of Eliza is particularly instructive. Unlike early hypertext systems that were developed in answer to the vision of the memex, Eliza far exceeded expectations. Eliza's persuasiveness, her existence not as a program but as a perceived human being, as a character capable of inspiring theatrical belief, came as a shock to Joseph Weizenbaum. Turing had called for a similar system as a test of the powers of the computer to simulate a human being in free conversation, but Weizenbaum was offended by such confusions and dismayed to have inadvertently created a program that was mistakenly believed to have passed the Turing test. The widespread confusion over Eliza's potential as a real rather than a simulated and comic therapist, and Weizenbaum's attempts to straighten people out, were symptoms of the gap between our new ability to make digital artifacts and our inability to understand what we were making. Weizenbaum came to terms with his creation only after he was able to describe it in literary terms. His secretary who thought Eliza was a real therapist and his computer scientist friends who were charmed by her despite their understanding of the code were not deluded; they were merely engaging in the willing suspension of disbelief, as Coleridge had pointed out that theater goers do. But he missed the importance of this event: the discovery of a new literary medium, like the play or the novel or the sonnet—a medium that consisted of the writing of procedural rules and the engagement of an improvising interactor with the rule-governed system.

With the invention of Eliza, the computer had reached an important milestone: it had achieved the illusion of life through the rules of behavior. But it was not until the 1980s that practice became self-conscious enough to allow for a serious discourse about digital artifacts. For while computer scientists were laying down the technical foundation for such immersive and interactive environments, humanists were expanding our theoretical grasp of technologies of representation. Cultural critics and communications researchers, responding to the growth of television in the 1950s and its expansion in the 1960s, focused our attention on the media experience itself as a subject of analysis and encouraged a new interest in analyzing the varieties of media experiences. Newer media such as photography, radio, film, and television could now be seen in the longer history that stretched back beyond the printing press to oral composition and the invention of writing. Marshall McLuhan (◊13) in particular brought interest in media to the forefront with his playful and insightful aphoristic writings. Like the computer scientists who were inventing the foundational technologies of the coming Internet, McLuhan saw media as "extensions of man," a means to augment our powers of perception and communication. He celebrated this change, but he did so in the tone of an old testament prophet, acknowledging the threatening as well as the thrilling aspects of this new communicative power. Other critics were more distrustful, seeing the mass media as the means by which the existing power structures maintain the status quo. The basis of the much of the popular and academic discourse on the media of later decades begins in the 1960s with this fascination with, and distrust of, television. As a result digital enthusiasts often described their efforts as remediating the dangers of television (for example, in allowing two-way instead of only one-way communication), and digital skeptics condemned the new medium as amplifying the destructive powers of television (for example, in exercising even greater holding power over consumers, further alienating them from the "real" world).

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The technophobic response to computers, which was strong throughout the period covered here, was also an important part of the story, and it should continue to be so. The augmenting of human intellect remains an uncertain and even a perilous activity. Hitler's genocidal efficiency was made possible by sophisticated information processing. The census tools he relied on are mere crayon scratches compared with those a tyrant could now command to automate the knowledge of everything from our reading habits to our DNA. Surveillance can now be extended not just inside the walls of our houses but inside our brain where we can witness the retrieval of a memory almost neuron by neuron.

New media in any age are always distrusted media. Prometheus is a hero to some and a transgressor to others, and both are right. Fire warms and fire burns. It remains to be seen which of the anti-technological voices from the second half of the twentieth century will be of lasting importance. The technophobic response is most clearly useful when it spurs us to question the uses to which we put technology and to guard against the dangers of abuse. It is perhaps less persuasive when arguing the abandonment of a medium—whether it is print, photography, television, or computers—or when it argues for the cultural or moral superiority of one means of expression over another, regardless of the content. But the anxieties aroused by a new medium are real, and worthy of attending to. The critics of technology are an important part of the development of a new medium because they challenge us to identify more clearly what we find so compelling about it, why we are so drawn to shape this new clay into objects that have not existed before.

Throughout the 1970s the humanities expanded its critical vocabulary and sophistication in understanding the process of representation, applying the same focused analysis to mass communication and cultural rituals (such as advertising posters and sports events) as had formerly been directed toward great works of literature. And as the postwar babies came into maturity, eager to understand and transcend the destructive history of the 20th century, ideology itself became an important subject of study, especially its embodiment in cultural artifacts within both high and low culture. The political insights of the 1960s combined with the methodologies of semiotics and its successors were applied to every aspect of human society, including the discourses of humanism itself—with devastating results. The great pillars of knowledge and social coherence were exposed as tyrannical at worst, delusional at best. All was ideology, and at the bottom of these vast nested pyramids of ideological representation was language itself, which was left to point at nothing real beyond our own consciousness, nothing external beyond our shared hallucinations. The signifiers of cultural discourse by which we defined our lives—faith, love, gender, family, nation, morality—pointed at one another in a dizzyingly infinite regression. In short, for humanists of the late 20th century the tools of analysis were increasing, but the content of the analysis was disorienting. We understood how human beings constructed meaning better than we had ever done before; but we no longer could believe in anything that we asserted. This condition, which came to be thought of as postmodernism, was one that called for new forms of artistic expression that simultaneously utilized and distanced themselves from the great traditions of cultural expression. It was the age of the put-on, an ironic age in which even the most exuberant expressions had a bitter aftertaste, and much of the most ambitious work possessed a cold derisive quality, a sense that everything had been said before and that it was all lies. Academic discourse was infected with word-play that substituted allusion for assertion as its prevalent rhetorical style.

For the computer scientists, on the other hand, the 1970s were a time of great earnestness and exhilarating possibilities as the computer was coming into its own as a new medium of representation. But while educational innovators like Alan Kay (◊26) and Seymour Papert (◊28) were celebrating the computer as a new and powerful tool for the active construction of meaning, artists and humanists were celebrating deconstruction, finding evidence in high and low culture throughout the world of the inevitable unraveling of meaning. All throughout the 1970s while university-based researchers were enjoying the new Internet technologies, and the computer was growing as a vehicle for connection and imaginative engagement—the discourse of humanism was growing increasingly fragmented and distrustful of the constructive imagination.

Of course the humanists were not inventing the postmodern condition—they were merely chronicling it, registering and giving form to the cultural anxiety caused by the loss of faith in the great human meta-narratives of sacred and secular salvation. At the heart of the most ironic deconstruction of outworn conventions was a celebration of expressivity itself, a delight in throwing off the monolithic straightjacket in favor of an antic, mutable series of costumes, of foregoing the longing for the end of the story in order to revel in the possibilities of the middle. What was missing was a form that could contain so many middles and such a sustained refusal of an ending.

The 1980s marked the beginning of the shift. For many humanists a key component of this change was provided by Deleuze and Guattari (◊27) who, without thinking of

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computers at all, offered a metaphor for intellectual discourse that served as a bridge for many humanists to the otherwise alien world of the machine. The two philosophers suggested a new model of textual organization to replace the ideologically suspect hierarchies of the old print-based world. The new ideal of form was the rhizome—an erudite word for a very down to earth thing: a potato root system. It was as if Deleuze and Guattari had dug beneath the forking path garden of Borges (which after all was still a hierarchy of sorts) and come up with an even more profound labyrinth, but one that offers the hope of knowability and a metaphor of healthy growth. The potato root system has no beginning, no end, and grows outward and inward at the same time. It forms a pattern familiar to computer scientists: a network with discrete interconnected nodes. Here was a way out of the pullulating paralysis, one that went beyond the subversion of all existing hierarchies. Here was a way of constructing something new. The humanist project of shredding culture had found a radical new pattern of meaning, a root system that offered a metaphor of growth and connection rather than rot and disassembly.

The gift of this metaphor at the beginning of the 1980s coincided with the introduction of the first personal computers and the introduction of word processing software, bringing a new accessibility of computational power to those outside the computer lab. At the more privileged educational institutions, the 1980s brought gifts of equipment and grant money that allowed for hitherto unprecedented collaborations between engineers and humanists. George Landow at Brown University, Gregory Crane at Harvard, Larry Friedlander at Stanford, and others gained access to sophisticated computational systems and began applying them to the representation of networked knowledge systems, working in fields such as Victorian culture, Ancient Greece, and Shakespeare. In North Carolina, J. David Bolter (◊47), Michael Joyce (◊42), and John Smith invented Storyspace, a hypertext system specifically designed for storytelling, which greatly expanded the use of computers in the humanities. With the arrival of HyperCard and similar notecard-based systems the personal computer came into usefulness throughout the educational system as a location for the creation of educational resources by teachers and students, rivaling the development of textbooks. These authoring environments and applications programs of the 1980s marked a new era in the expressiveness of the medium, by opening up the encyclopedic and spatial properties of the computer to wider communities of practices, communities composed not of programmers but of artists, writers, and educators.

While the academically-rooted experiments with hypertext took their course and found their enthusiastic but relatively small audiences, the video game was growing into a entertainment form to rival movies and television. Video games were successful because, as Brenda Laurel (◊38) pointed out, they exploited the computer's capacity to "represent action in which humans could participate." The videogame also won over the young to the new medium and developed an expanding vocabulary of engagement, including ever more detailed and intricate elaboration on the theme of the violent contest as well as increasing interest in creating detailed, immersive, expressive story worlds.

The expansion of practice was accompanied by another mark of a maturing medium, the moment at which computer practice became widespread enough to become an object of study in itself. Sherry Turkle (◊34) offered the foundational view of the psychosocial dynamics of the digital medium, calling it a "second self" upon which we projected consciousness, and an "evocative object" which had tremendous "holding power" over the interactor. The first online communities were forming and began to display the complex social relationships so well captured in the account by Morningstar and Farmer (◊46) of Lucasfilm's Habitat. The conflict between player killing and community building in that world was mirrored by the conflict between those, like Richard Stallman (◊36), who wanted a distributed, cooperative open programming community and the commercial influences, now personified by Microsoft, who wanted to standardize development on closed, centrally controlled systems. The computer began to emerge as a noticeable entity in the social world, with its utopian and dystopian promises now the subject of explicit policy debates.

The 1980s also marked the beginning of our understanding of interactive design as a new field of study, the beginning of the self-conscious creation of digital artifacts not by small teams of researchers but by a newly defined profession. Apple established guidelines for its graphical user interface, allowing multiple developers to use

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the same conventions for the same functions. The original focus of design, building on the industrial design insights of Donald Norman and others, placed emphasis on the "interface." Shneiderman (◊33), Laurel (◊38), and Winograd (◊37) moved the emphasis to the human actor and the shaping of the interaction. This change was marked by the movement of the field from Computer Human Interface to Human Computer Interaction, from CHI (which is still the designation of the special interest group of the ACM which holds the central meeting in the field) to HCI (which is what universities now teach and give degrees in).

The humanities and arts became more visible to the engineers as computers became more available to the humanists. The spatial property of the medium brought forth a new interest in architecture; the participatory property provoked interest in improvisational theater. The teams who produced new application software, new educational environments, and new "multimedia" games became intentionally interdisciplinary. As they struggled to understand one another's conflicting design criteria, new academic programs arose to educate professionals for a rapidly morphing field.

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By the end of the 1980s the computer had emerged as an everyday tool for business, education, and entertainment. But it was primarily a desktop tool, networked to a few co-workers perhaps. Those who were using the Internet on a regular basis were mostly using it for email or for the uploading and downloading of files between home and office machines or perhaps among a small circle of close collaborators. This was to change dramatically with the invention of the World Wide Web, which is the subject of the final essay in this anthology.

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It is fitting that this chronicle of joint invention ends with Tim Berners-Lee (◊54), who is both inventor and culture hero. Berners-Lee set out to solve a technical problem of information flow, to simplify the communication of the worldwide community of physics. He changed the model of communication from passing around containers of information (streaming bits identified by filename) to passing around viewable documents (Web pages). By displaying the documents on the screen and at a distance, he opened up the possibility of a true global library, an ultimate Alexandria. He also, somewhat inadvertently, opened up a new marketplace. The World Wide Web stands at the crossroads of many of the strands within this volume, combining Stallman's passion for open standards with Negroponte's (◊23) enchantment with "bits" (replacing "atoms") as a global commodity. It is the best embodiment so far of the encyclopedic, labyrinthine fantasies of the memex and the potato garden. It allows for previously unimaginable levels of surveillance—webcams operating 24/7 in the service of science, tourism, exhibitionism, policing, stalking, and even pure whimsy, monitoring, for instance, the state of a coffee pot in a lab halfway around the world. The Web also provides participatory experiences with such ease of availability that gaming is often described in the press as a threat to productivity in the office and to learning from kindergarten through college. And over the horizon is a faster connection, a bigger data pipe, a more elegantly designed indexing, retrieval, and display system, a more tactile interface, a more complete convergence of entertainment media into interactive TV and of museums, libraries, universities into a single digital information source. The title of one active current field of design could stand as summary for the whole effort at the turn of the 21st century: we are moving toward a world of *ubiquitous computing*. And a key enabling technology behind this change is the coherent transmission of information across multiple platforms with standardized protocols like those that now underlie the Web.

But as important as Tim Berners-Lee's technical work is his role as culture hero of the information age. Instead of commercializing his invention, Berners-Lee established an open Web standard, administered in the interest of uniting all the worlds' information sources into ever larger and more coherent units. Berners-Lee's grand gesture of renunciation (as it is often described) is a counter-fable to the one with which this anthology begins. The spy in the forking garden is a tool of the meaning machine, bound to transmit messages at any cost (messages that carry no meaning to him) in obedience to the prevailing social order, the order of competition to the death. The Berners-Lee fable, on the other hand, celebrates a refusal to commodify the message, an affirmation of meaning over money, of world cooperation over global competition. It offers a way out of the pullulating, paralyzed consciousness of meaningless. It offers a fulfillment in part of Bush's vision. In the world of structured Web pages, we agree on metadata that will link one bit of

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information with its counterpart across the globe, annotated by another hand. We make multiple patterns and change them kaleidoscopically to express many views of the same data, the same object, the same event. The promise of the Web, not as it is, but as it could be, is like that of the book before it: it will allow us to say more complicated things to more people with greater understanding. The promise is that we will not be crushed by our own knowledge, as the writers at the beginning of this period anticipated, because we will organize it together in a vast distributed and synchronized effort. We will not be mere prisoners of the labyrinth, nor even trail-blazers: we will be the makers of the labyrinth, the gods of our own machines.

Perhaps the most amazing thing in all these essays is the record of perseverance. What would make us engage with machines for fifty years despite their core stupidity, their 0s and 1s and their propensity to crash, their maddening literalness and oblivious torpor? Why do we struggle to make them coherent and expressive despite all that can be said of their inhuman rigidity and still primitive state? Why do human beings choose at this time in our cultural history to communicate with one another by making complex artifacts out of electrical impulses? For the same reason that we couldn't put down the stylus or the whittling knife. We are drawn to a new medium of representation because we are pattern makers who are thinking beyond our old tools. We cannot rewind our collective cognitive effort, since the digital medium is as much a pattern of thinking and perceiving as it is a pattern of making things. We are drawn to this medium because we need it to understand the world and our place in it.

To return to Bush's speculations: now that we have shaped this a new medium of expression, *how may we think?* We may, if we are lucky and mindful enough, learn to think together by building shared structures of meaning. How will we escape the labyrinth of deconstructed ideologies and self-reflective signs? We will, if we are lucky enough and mindful enough, invent communities of communication at the widest possible bandwidth and smallest possible granularity.

We need not imagine ourselves stranded somewhere over the evolutionary horizon, separated from our species by the power of our own thinking. The machine like the book and the painting and the symphony and the photograph is made in our own image, and reflects it back again. The task is the same now as it ever has been, familiar, thrilling, unavoidable: we work with all our myriad talents to expand our media of expression to the full measure of our humanity.

New Media from Borges to HTML

Lev Manovich

The New Media Field: a Short Institutional History

The appearance of *The New Media Reader* is a milestone in the history of a new field that, just a few years ago, was somewhat of a cultural underground. Before taking up the theoretical challenge of defining what new media actually is, as well as discussing the particular contributions this reader makes to answering this question, I would like very briefly to sketch the history of the field for the benefit of whose who are newcomers to it.

If we are to look at any modern cultural field sociologically, measuring its standing by the number and the importance of cultural institutions devoted to it such as museum exhibitions, festivals, publications, conferences, and so on, we can say that in the case of new media (understood as computer-based artistic activities) it took about ten years for it to move from cultural periphery to the mainstream. Although SIGGRAPH in the United States and Ars Electronica in Austria had already acted as annual gathering places of artists working with computers since the late 1970s, the new media field began to take real shape only in the end of the 1980s. Around that time new institutions devoted to the production and support of new media art were founded in Europe: ZKM in Karlsruhe (1989), New Media Institute in Frankfurt (1990), and ISEA (Inter-Society for the Electronic Arts) in the Netherlands (1990). (Jeffrey Shaw was appointed to be director of the part of ZKM focused on visual media while the Frankfurt Institute was headed by Peter Weibel.) In 1990 as well, Intercommunication Center in Tokyo began its activities in new media art (it moved into its own building in 1997). Throughout the 1990s, Europe and Japan remained the best places to see new media work and to participate in high-level discussions of the new field. Festivals such as ISEA, Ars Electronica, and DEAF have been required places of pilgrimage for interactive installation artists, computer musicians, choreographers working with computers, media curators, critics, and, since the mid-1990s, net artists.

As was often the case throughout the twentieth century, countries other than the United States were first to critically engage with new technologies developed and deployed in the United States. There are a few ways to explain this phenomenon. Firstly, the speed with which new technologies are assimilated in the United States makes them "invisible" almost overnight: they become an assumed part of the everyday existence, something which does not seem to require much reflection. The slower speed of assimilation and the higher costs involved give other countries more time to reflect upon new technologies, as it was the case with new media and the Internet in the 1990s. In the case of the Internet, by the end of the 1990s it became as commonplace in the United States as the telephone, while in Europe the Internet still remained a phenomenon to reflect upon, both for economic reasons (U.S. subscribers would pay a very low monthly flat fee; in Europe they had to pay by the minute) and for cultural reasons (a more skeptical attitude towards new technologies in many European countries slowed down their assimilation). So when in the early 1990s the Soros Foundation set up contemporary art centers throughout the Eastern Europe, it wisely gave them a mandate to focus their activities on new media art, both in order to support younger artists who had difficulty getting around the more established "art mafia" in these countries and also in order to introduce the general public to the Internet.

Secondly, we can explain the slow U.S. engagement with new media art during the 1990s by the very minimal level of the public support for the arts there. In Europe, Japan, and Australia festivals for media and new media art such as the ones I mentioned above, commissions for artists to create such work, exhibition catalogs and other related cultural activities were funded by the governments. In the United States the lack of government funding for the arts left only two cultural players which economically could have supported creative work in new media: anti-intellectual, market- and cliché-driven commercial mass culture and equally commercial art culture (i.e., the art market). For different reasons, neither of these players would support new media art nor would foster intellectual discourse about it. Out of the two, commercial culture (in other words, culture designed for mass audiences) has played a more progressive role in adopting and

experimenting with new media, even though for obvious reasons the content of commercial new media products has had severe limits. Yet without commercial culture we would not have computer games using artificial intelligence; network-based multimedia (including various Web plug-ins which enable distribution of music, moving images and 3-D environments over the Web); sophisticated 3-D modeling; animation and rendering tools; database-driven Web sites; CD-ROMs, DVDs, and other storage formats; and most other advanced new media technologies and forms.

The 1990s the U.S. art world proved to be the most conservative cultural force in contemporary society, lagging behind the rest of the cultural and social institutions in dealing with new media technologies. (In the 1990s a standard joke at new media festivals was that a new media piece requires two interfaces: one for art curators and one for everybody else.) This resistance is understandable given that the logic of the art world and the logic of new media are exact opposites. The first is based the romantic idea of authorship which assumes a single author, the notion of a one-of-a-kind art object, and the control over the distribution of such objects which takes place through a set of exclusive places: galleries, museums, auctions. The second privileges the existence of potentially numerous copies; infinitely many different states of the same work; author-user symbiosis (the user can change the work through interactivity); the collective; collaborative authorship; and network distribution (which bypasses the art system distribution channels). Moreover, exhibition of new media requires a level of technical sophistication and computer equipment which neither U.S. museums nor galleries were able to provide in the 1990s. In contrast, in Europe generous federal and regional funding allowed not only for mountings of sophisticated exhibitions but also for the development of a whole new form of art: the interactive computer installation. It is true that after many years of its existence, the U.S. art world learned how to deal with and in fact fully embraced video installation—but video installations require standardized equipment and don't demand constant monitoring. Neither is the case with interactive installations or even with Web pieces. While in Europe equipment-intensive forms of interactive installation have flourished throughout the 1990s, the U.S. art world has taken the easy way out by focusing on "net art," i.e., Web-based pieces whose exhibition does not require much resources beyond an off-the-shelf computer and a net connection.

All this started to change with increasing speed by the end of the 1990s. Various cultural institutions in the United States finally began to pay attention to new media. The first were education institutions. Around 1995 universities and art schools, particularly on the West Coast, began to initiate programs in new media art and design as well as open faculty positions in these areas; by the beginning of the new decade, practically every university and art school on the West Coast had both undergraduate and graduate programs in new media. A couple of years later museums such as Walker Art Center begun to mount a number of impressive online exhibitions and started to commission online projects. The 2000 Whitney Biannual included a room dedicated to net art (even though its presentation conceptually was ages behind the presentation of new media in such places as Ars Electronica Center in Linz, Intercommunication Center in Tokyo, or ZKM in Germany). Finally in 2001, both the Whitney Museum in New York and the San Francisco Museum of Modern art (SFMOMA) mounted large survey exhibitions of new media art (*Bitstreams* at the Whitney, *010101: Art in Technological Times* at SFMOMA). Add to this a constant flow of conferences and workshops mounted in such bastions of American Academia as the Institute for Advanced Studies in Princeton; fellowships in new media initiated by such prestigious funding bodies as the Rockefeller Foundation and Social Science Research Council (both begun in 2001); book series on new media published by such well-respected presses as the MIT Press. What ten years ago was a cultural underground became an established academic and artistic field; what has emerged from on-the-ground interactions of individual players has solidified, matured, and acquired institutional forms.

Paradoxically, at the same time as the new media field started to mature (the end of the 1990s), its very reason for existence came to be threatened. If all artists now, regardless of their preferred media, also routinely use digital computers to create, modify, and produce works, do we need to have a special field of new media art? As digital and network media rapidly become an omnipresent in our society, and as most artists came to routinely use these new media, the field is facing a danger of becoming a ghetto whose participants would be united by their fetishism of latest computer

technology, rather than by any deeper conceptual, ideological or aesthetic issues—a kind of local club for photo enthusiasts. I personally do think that the existence of a separate new media field now and in the future makes very good sense, but it does require a justification—something that I hope the rest of this text, by taking up more theoretical questions, will help to provide.

Software Design and Modern Art: Parallel Projects

Ten years after the appearance of the first cultural institutions solely focused on new media, the field has matured and solidified. But what exactly is new media? And what is new media art? Surprisingly, these questions remain not so easy to answer. The book you are now holding in your hands does provide very interesting answers to these questions; it also provides the most comprehensive foundation for the new media field, in the process redefining it in a very productive way. In short, this book is not just a map of the field as it already exists but a creative intervention into it.

The particular selections and their juxtaposition this book re-define new media as parallel tendencies in modern art and computing technology after the World War II. Although the editors of the anthology may not agree with this move, I would like to argue that eventually this parallelism changes the relationship between art and technology. In the last few decades of the twentieth century, modern computing and network technology materialized certain key projects of modern art developed approximately at the same time. In the process of this materialization, the technologies overtook art. That is, not only have new media technologies—computer programming, graphical human-computer interface, hypertext, computer multimedia, networking (both wired-based and wireless)—actualized the ideas behind projects by artists, they have also extended them much further than the artists originally imagined. As a result these technologies themselves have become the greatest art works of today. The greatest hypertext is the Web itself, because it is more complex, unpredictable and dynamic than any novel that could have been written by a single human writer, even James Joyce. The greatest interactive work is the interactive human-computer interface itself: the fact that the user can easily change everything which appears on her screen, in the process changing the internal state of a computer or even commanding reality outside of it. The greatest avant-garde film is software such as Final Cut Pro or After Effects which contains the possibilities of combining together thousands of separate tracks into a single movie, as well as setting various relationships between all these different tracks—and it thus it develops the avant-garde idea of a film as an abstract visual score to its logical end, and beyond. Which means that those computer scientists who invented these technologies—J. C. R. Licklider (◊05), Douglas Engelbart (◊08. ◊16), Ivan Sutherland (◊09), Ted Nelson (◊11, ◊21, ◊30), Seymour Papert (◊28), Tim Berners-Lee (◊54), and others—are the important artists of our time, maybe the only artists who are truly important and who will be remembered from this historical period.

To prove the existence of historical parallelism, *The New Media Reader* positions next to each of the key texts by modern artists that articulate certain ideas those key texts by modern computer scientists that articulate similar ideas in relation to software and hardware design. Thus we find next to each other a story by Jorge Luis Borges (1941) (◊01) and an article by Vannevar Bush (1945) (◊02) which both contain the idea of a massive branching structure as a better way to organize data and to represent human experience.

The parallelism between texts by artists and by computer scientists involves not only the ideas in the texts but also the form of the texts. In the twentieth century artists typically presented their ideas either by writing manifestos or by creating actual art works. In the case of computer scientists, we either have theoretical articles that develop plans for particular software and/or hardware designs or more descriptive articles about already created prototypes or the actual working systems. Structurally manifestos correspond to the theoretical programs of computer scientists, while completed artworks correspond to working prototypes or systems designed by scientists to see if their ideas do work and to demonstrate these ideas to colleagues, sponsors and clients. Therefore *The New Media Reader* to a large extent consists of these two types of texts: either theoretical presentations of new ideas and speculations about projects (or types of projects) that would follow from them; or the descriptions of the projects actually realized.

Institutions of modern culture that are responsible for selecting what makes it into the canon of our cultural

memory and what is left behind are always behind the times. It may take a few decades or even longer for a new field which is making an important contribution to modern culture to "make it" into museums, books, and other official registers of cultural memory. In general, our official cultural histories tend to privilege art (understood in a romantic sense as individual products an individual artists) over mass industrial culture. For instance, while modern graphical and industrial designers do have some level of cultural visibility, their names, with the exception of a few contemporary celebrity designers such as Bruce Mau and Philip Stark, are generally not as known as the names of fine artists or fiction writers. Some examples of key contemporary fields that so far have not been given their due are music videos, cinematography, set design, and industrial design. But no cultural field so far has remained more unrecognized than computer science and, in particular, its specific branch of human-computer interaction, or HCI (also called human-computer interface design).

It is time that we treat the people who have articulated fundamental ideas of human-computer interaction as the major modern artists. Not only did they invent new ways to represent any data (and thus, by default, all data which has to do with "culture," i.e. the human experience in the world and the symbolic representations of this experience) but they have also radically redefined our interactions with all of old culture. As the window of a Web browser comes to supplement the cinema screen, museum space, CD player, book, and library, the new situation manifests itself: all culture, past and present, is being filtered through the computer, with its particular human-computer interface. Human-computer interface comes to act as a new form through which all older forms of cultural production are being mediated.

The New Media Reader contains essential articles by some of the key interface and software designers in the history of computing so far, from Engelbart to Berners-Lee. Thus in my view this book is not just an anthology of new media but also the first example of a radically new history of modern culture—a view from the future when more people will recognize that the true cultural innovators of the last decades of the twentieth century were interface designers, computer game designers, music video directors and DJs — rather than painters, filmmakers, or fiction writers, whose fields remained relatively stable during this historical period.

What Is New Media? Eight Propositions

Having discussed the particular perspective adopted by *The New Media Reader* in relation to the larger cultural context we may want to place new media in—the notion of parallel developments in modern art and in computing—I now want to go through other possible concepts of new media and its histories (including a few proposed by the present author elsewhere). Here are eight answers; without a doubt, more can be invented if desired.

1 New Media versus Cyberculture

To begin with, we may distinguish between new media and cyberculture. In my view they represent two distinct fields of research. I would define cyberculture as the study of various social phenomena associated with the Internet and other new forms of network communication. Examples of what falls under cyberculture studies are online communities, online multi-player gaming, the issue of online identity, the sociology and the ethnography of email usage, cell phone usage in various communities, the issues of gender and ethnicity in Internet usage, and so on.[1] Notice that the emphasis is on the *social* phenomena; cyberculture does not directly deal with new cultural objects enabled by network communication technologies. The study of these objects is the domain of new media. In addition, new media is concerned with cultural objects and paradigms enabled by all forms of computing and not just by networking. To summarize: cyberculture is focused on the social and on networking; new media is focused on the cultural and computing.

2 New Media as Computer Technology Used as a Distribution Platform

What are these new cultural objects? Given that digital computing is now used in most areas of cultural production, from publishing and advertising to filmmaking and architecture, how can we single out the area of culture that specifically owes its existence to computing? In my *The Language of New Media* I begin the discussion of new media by invoking its definition which can be deduced from how the term is used in popular press: new media are the cultural objects which use digital computer technology for

distribution and exhibition.[2] Thus, Internet, Web sites, computer multimedia, computer games, CD-ROMs and DVDs, virtual reality, and computer-generated special effects all fall under new media. Other cultural objects which use computing for production and storage but not for final distribution—television programs, feature films, magazines, books and other paper-based publications, etc.—are not new media.

The problems with this definition are three-fold. Firstly, it has to be revised every few years, as yet another part of culture comes to rely on computing technology for distribution (for instance, the shift from analog to digital television; the shift from film-based to digital projection of feature films in movie theatres; e-books, and so on) Secondly, we may suspect that eventually most forms of culture will use computer distribution, and therefore the term "new media" defined in this way will lose any specificity. Thirdly, this definition does not tell us anything about the possible effects of computer-based distribution on the aesthetics of what is being distributed. In other words, do Web sites, computer multimedia, computer games, CD-ROMs, and virtual reality all have something in common because they are delivered to the user via a computer? Only if the answer is at least a partial yes does it makes sense to think about new media as a useful theoretical category.

3 New Media as Digital Data Controlled by Software

The Language of New Media is based on the assumption that, in fact, all cultural objects that rely on digital representation and computer-based delivery do share a number of common qualities. In the book I articulate a number of principles of new media: numerical representation, modularity, automation, variability, and transcoding. I do not assume that any computer-based cultural object will necessary be structured according to these principles today. Rather, these are tendencies of a culture undergoing computerization that gradually will manifest themselves more and more. For instance, the principle of variability states that a new media cultural object may exist in potentially infinitly many different states. Today the examples of variability are commercial Web sites programmed to customize Web pages for each user as she is accessing the site, or DJs remixes of already existing recordings; tomorrow the principle of variability may also structure a digital film which will similarly exist in multiple versions.

I deduce these principles, or tendencies, from the basic fact of digital representation of media. New media is reduced to digital data that can be manipulated by software as any other data. This allows automating many media operations, to generate multiple versions of the same object, etc. For instance, once an image is represented as a matrix of numbers, it can be manipulated or even generated automatically by running various algorithms, such as sharpen, blue, colorize, change contrast, etc.

More generally, extending what I proposed in my book, I could say that two basic ways in which computers model reality—through data structures and algorithms—can also be applied to media once it is represented digitally. In other words, given that new media is digital data controlled by particular "cultural" software, it make sense to think of any new media object in terms of particular data structures and/or particular algorithms it embodies.[3] Here are examples of data structures: an image can be thought of as a two-dimensional array (x, y), while a movie can be thought of as a three-dimensional array (x, y, t). Thinking about digital media in terms of algorithms, we discover that many of these algorithms can be applied to any media (such as copy, cut, paste, compress, find, match) while some still retain media specificity. For instance, one can easily search for a particular text string in a text but not for a particular object in an image. Conversely, one can composite a number of still or moving images together but not different texts. These differences have to do with different semiotic logics of different media in our culture: for example, we are ready to read practically any image or a composite of images as being meaningful, while for a text string to be meaningful we require that it obey the laws of grammar. On the other hand, language has a priori discrete structure (a sentence consists of words which consist if morphemes, and so on) that makes it very easily to automate various operations on it (such as search, match, replace, index), while digital representation of images does not by itself allow for automation of semantic operations.

4 New Media as the Mix Between Existing Cultural Conventions and the Conventions of Software

As a particular type of media is turned into digital data controlled by software, we may expect that eventually it will fully obey the principles of modularity, variability, and automation. However, in practice these processes may take a long time and they do not proceed in a linear fashion—rather, we witness "uneven development." For instance, today some media are already totally automated while in other cases this automation hardly exists—even though technologically it can be easily implemented.

Let us take as the example contemporary Hollywood film production. Logically we could have expected something like the following scenario. An individual viewer receives a customized version of the film that takes into account her/his previous viewing preferences, current preferences, and marketing profile. The film is completely assembled on the fly by AI software using pre-defined script schemas. The software also generates, again on the fly, characters, dialog, and sets (this makes product placement particularly easy) that are taken from a massive "assets" database.

The reality today is quite different. Software is used in some areas of film production but not in others. While some visuals may be created using computer animation, cinema still centers on the system of human stars whose salaries account for a large percent of a film budget. Similarly, script writing (and countless re-writing) is also trusted to humans. In short, the computer is kept out of the key "creative" decisions, and is delegated to the position of a technician.

If we look at another type of contemporary media—computer games—we will discover that they follow the principle of automation much more thoroughly. Game characters are modeled in 3D; they move and speak under software control. Software also decides what happens next in the game, generating new characters, spaces, and scenarios in response to user's behavior. It is not hard to understand why automation in computer games is much more advanced than in cinema. Computer games are one of the few cultural forms "native" to computers; they began as singular computer programs (before turning into a complex multimedia productions which they are today)—rather than being an already established medium (such as cinema) which is now slowly undergoing computerization.

Given that the principles of modularity, automation, variability and transcoding are tendencies that slowly and unevenly manifest themselves, is there a more precise way to describe new media, as it exists today? *The Language of New Media* analyzes the language of contemporary new media (or, to put this differently, "early new media") as the mix (we can also use software metaphors of "morph" or "composite") between two different sets of cultural forces, or cultural conventions: on the one hand, the conventions of already mature cultural forms (such as a page, a rectangular frame, a mobile point of view) and, on the other hand, the conventions of computer software and, in particular, of HCI, as they have developed until now.

Let me illustrate this idea with two examples. In modern visual culture a representational image was something one gazed at, rather than interacted with. An image was also one continuous representational field, i.e. a single scene. In the 1980s the graphical user interface (GUI) redefined an image as a figure-ground opposition between a non-interactive, passive ground (typically a desktop pattern) and active icons and hyperlinks (such as the icons of documents and applications appearing on the desktop). The treatment of representational images in new media represents a mix between these two very different conventions. An image retains its representational function while at the same time is treated as a set of hot spots ("image-map"). This is the standard convention in interactive multimedia, computer games, and Web pages. So while visually an image still appears as a single continuous field, in fact it is broken into a number of regions with hyperlinks connected to these regions, so clicking on a region opens a new page, or re-starts the game narrative, etc.

This example illustrates how a HCI convention is "superimposed" (in this case, both metaphorically and literally, as a designer places hot spots over an existing image) over an older representational convention. Another way to think about this is to say that a technique normally used for control and data management is mixed with a technique of fictional representation and fictional narration. I will use another example to illustrate the opposite process: how a cultural convention normally used for fictional representation and narration is "superimposed" over software techniques of data management and presentation.

The cultural convention in this example is the mobile camera model borrowed from cinema. In *The Language of New Media* I analyze how it became a generic interface used to access any type of data:

> Originally developed as part of 3D computer graphics technology for such applications as computer-aided design, flight simulators, and computer movie making, during the 1980s and 1990s the camera model became as much of an interface convention as scrollable windows or cut and paste operations. It became an accepted way for interacting with any data which is represented in three dimensions—which, in a computer culture, means literally anything and everything: the results of a physical simulation, an architectural site, design of a new molecule, statistical data, the structure of a computer network and so on. As computer culture is gradually spatializing all representations and experiences, they become subjected to the camera's particular grammar of data access. Zoom, tilt, pan, and track: we now use these operations to interact with data spaces, models, objects and bodies.[4]

To sum up: new media today can be understood as the mix between older cultural conventions for data representation, access, and manipulation and newer conventions of data representation, access, and manipulation. The "old" data are representations of visual reality and human experience, i.e., images, text-based and audio-visual narratives—what we normally understand by "culture." The "new" data is numerical data.

As a result of this mix, we get such strange hybrids as clickable "image-maps," navigable landscapes of financial data, QuickTime (which was defined as the format to represent any time-based data but which in practice is used exclusively for digital video), animated icons—a kind of micro-movies of computer culture—and so on.

As can be seen, this particular approach to new media assumes the existence of historically particular aesthetics that characterize new media, or "early new media," today. (We may also call it the "aesthetics of early information culture.") This aesthetics results from the convergence of historically particular cultural forces: already existing cultural conventions and the conventions of HCI. Therefore, it could not have existed in the past and it unlikely to stay without changes for a long time. But we can also define new media in the opposite way: as specific aesthetic features which keep re-appearing at an early stage of deployment of every new modern media and telecommunication technology.

5 New Media as the Aesthetics that Accompanies the Early Stage of Every New Modern Media and Communication Technology

Rather than reserving the term "new media" to refer to the cultural uses of current computer and computer-based network technologies, some authors have suggested that every modern media and telecommunication technology passes through its "new media stage." In other words, at some point photography, telephones, cinema, and television each were "new media." This perspective redirects our research efforts: rather than trying to identify what is unique about digital computers functioning as media creation, media distribution and telecommunication devices, we may instead look for certain aesthetic techniques and ideological tropes which accompany every new modern media and telecommunication technology at the initial stage of their introduction and dissemination. Here are a few examples of such ideological tropes: new technology will allow for "better democracy;" it will give us a better access to the "real" (by offering "more immediacy" and/or the possibility "to represent what before could not be represented"); it will contribute to "the erosion of moral values"; it will destroy the "natural relationship between humans and the world" by "eliminating the distance" between the observer and the observed.

And here are two examples of aesthetic strategies that seem to often accompany the appearance of a new media and telecommunication technology (not surprisingly, these aesthetic strategies are directly related to ideological tropes I just mentioned). In the mid 1990s a number of filmmakers started to use inexpensive digital cameras (DV) to create films characterized by a documentary style (for instance, *Timecode, Celebration, Mifune*). Rather than treating live action as a raw material to be later re-arranged in post-production, these filmmakers placed premier importance on the authenticity of the actors' performances. DV equipment is small enough to allow a filmmaker to literally be inside the action as it unfolds. In addition to adopting a more intimate filmic approach, a filmmaker can keep shooting for a whole

duration of a 60 or 120 minute DV tape as opposed to the standard ten-minute film roll. This gives the filmmaker and the actors more freedom to improvise around a theme, rather than being shackled to the tightly scripted short shots of traditional filmmaking. (In fact the length of *Timecode* exactly corresponds to the length of a standard DV tape.)

These aesthetic strategies for representing the real, which at first may appear to be unique to digital revolution in cinema, are in fact not unique. DV-style filmmaking has a predecessor in an international filmmaking movement that begun in the late 1950s and unfolded throughout the 1960s. Called "direct cinema," "candid" cinema, "uncontrolled" cinema, "observational" cinema, or *cinéma vérité* ("cinema truth"), it also involved filmmakers using lighter and more mobile (in comparison to what was available before) equipment. Like today's "DV realists," the 1960s "direct cinema" proponents avoided tight staging and scripting, preferring to let events unfold naturally. Both then and now, the filmmakers used new filmmaking technology to revolt against the existing cinema conventions that were perceived as being too artificial. Both then and now, the key word of this revolt was the same: "immediacy."

My second example of similar aesthetic strategies re-appearing deals with the development of moving image technology throughout the nineteenth century and the development of digital technologies to display moving images on a computer desktop during the 1990s. In the first part of the 1990s, as computers' speed kept gradually increasing, CD-ROM designers were able to go from a slide show format to the superimposition of small moving elements over static backgrounds and finally to full-frame moving images. This evolution repeats the nineteenth century progression: from sequences of still images (magic lantern slides presentations) to moving characters over static backgrounds (for instance, in Reynaud's Praxinoscope Theater) to full motion (the Lumieres' cinematograph). Moreover, the introduction of QuickTime by Apple in 1991 can be compared to the introduction of the Kinetoscope in 1892: both were used to present short loops, both featured the images approximately two by three inches in size, both called for private viewing rather than collective exhibition. Culturally, the two technologies also functioned similarly: as the latest technological "marvel." If in the early 1890s the public patronized Kinetoscope parlors where peep-hole machines presented them with the latest invention—tiny moving photographs arranged in short loops; exactly a hundred years later, computer users were equally fascinated with tiny QuickTime movies that turned a computer in a film projector, however imperfect. Finally, the Lumieres' first film screenings of 1895 which shocked their audiences with huge moving images found their parallel in 1995 CD-ROM titles where the moving image finally fills the entire computer screen (for instance, in the *Johnny Mnemonic* computer game, based on the film by the same title). Thus, exactly a hundred years after cinema was officially "born," it was reinvented on a computer screen.

Interesting as they are, these two examples also illustrate the limitations of thinking about new media in terms of historically recurrent aesthetic strategies and ideological tropes. While ideological tropes indeed seem to be reappearing rather regularly, many aesthetic strategies may only reappear two or three times. Moreover, some strategies and/or tropes can be already found in the first part of the nineteenth century while others only made their first appearance much more recently.[5] In order for this approach to be truly useful it would be insufficient to simply name the strategies and tropes and to record the moments of their appearance; instead, we would have to develop a much more comprehensive analysis which would correlate the history of technology with social, political, and economical histories of the modern period.

So far my definitions of new media have focused on technology; the next three definitions will consider new media as material re-articulation, or encoding, of purely cultural tendencies—in short, as ideas rather than technologies.

6 New Media as Faster Execution of Algorithms Previously Executed Manually or through Other Technologies

A modern digital computer is a programmable machine. This simply means that the same computer can execute different algorithms. An algorithm is a sequence of steps that need to be followed to accomplish a task. Digital computers execute most algorithms very quickly—however in principle an algorithm, since it is just a sequence of simple steps, can also be executed by a human, although much more slowly. For instance, a human can sort files in a particular order, or count the number of words in a text, or cut a part of an image and paste it in a different place.

This realization gives us a new way to think about both digital computing, in general, and new media in particular as a massive speed-up of various manual techniques that all have already existed. Consider, for instance, the computer's ability to represent objects in linear perspective and to animate such representations. When you move your character through the world in a first person shooter computer game (such as *Quake*), or when you move your viewpoint around a 3D architectural model, a computer re-calculates perspectival views for all the objects in the frame many times every second (in the case of current desktop hardware, frame rates of 80 frames a second are not uncommon). But we should remember that the algorithm itself was codified during the Renaissance in Italy, and that, before digital computers came along (that is, for about five hundred years) it was executed by human draftsmen. Similarly, behind many other new media techniques there is an algorithm that, before computing, was executed manually. (Of course since art has always involved some technology—even as simple as a stylus for making marks on stone—what I mean by "manually" is that a human had to systematically go through every step of an algorithm himself, even if he was assisted by some image making tools.) Consider, for instance, another very popular new media technique: making a composite from different photographs. Soon after photography was invented, such nineteenth century photographers as Henry Peach Robinson and Oscar G. Rejlander were already creating smooth "combination prints" by putting together multiple photographs.

While this approach to thinking about new media takes us away from thinking about it purely in technological terms, it has a number of problems of its own. Substantially speeding up the execution of an algorithm by implementing this algorithm in software does not just leave things as they are. The basic point of dialectics is that a substantial change in quantity (i.e., in speed of execution in this case) leads to the emergence of qualitatively new phenomena. The example of automation of linear perspective is a case in point. Dramatically speeding up the execution of a perspectival algorithm makes possible previously non-existent representational technique: smooth movement through a perspectival space. In other words, we get not only quickly produced perspectival drawings but also computer-generated movies and interactive computer graphics.

The technological shifts in the history of "combination prints" also illustrate the cultural dialectics of trans-formation of quantity into quality. In the nineteenth century, painstakingly crafted "combination prints" represented an exception rather than the norm. In the twentieth century, new photographic technologies made possible photomontage that quickly became one of the basic representational techniques of modern visual culture. And finally the arrival of digital photography via software like Photoshop as well as scanners and digital cameras, in the late 1980s and 1990s, not only made photomontage much more omnipresent than before but it also fundamentally altered its visual characteristics. In place of graphic and hard-edge compositions pioneered by Moholy-Nagy and Rodchenko we now have smooth multi-image composites which use transparency, blur, colorization, and other easily available digital manipulations and which often incorporate typography that is subjected to exactly the same manipulations (thus in post-Photoshop visual culture the type becomes a subset of a photo-based image). To see this dramatic change, it is enough to compare a typical music video from 1985 and a typical music video from 1995: within ten years, the visual aesthetics of photomontage had undergone a fundamental change.

Finally, thinking about new media as speeding up of algorithms which previously were executed by hand foregrounds the use of computers for fast algorithm execution, but ignores two other essential uses: real-time network communication and real-time control. The abilities to interact with or control remotely located data in real time, to communicate with other human beings in real time, and control various technologies (sensors, motors, other computers) in real time constitute the very foundation of our information society—phone communications, Internet, financial networking, industrial control, the use of micro-controllers in numerous modern machines and devices, and so on. They also make possible many forms of new media art and culture: interactive net art, interactive computer installations, interactive multimedia, computer games, real-time music synthesis.

While non-real-time media generation and manipulation via digital computers can be thought of as speeding up of previously existing artistic techniques, *real-time* networking and control seem to constitute qualitatively new phenomena.

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When we use Photoshop to quickly combine photographs together, or when we compose a text using a Microsoft Word, we simply do much faster what before we were doing either completely manually or assisted by some technologies (such as a typewriter). However, in the cases when a computer interprets or synthesizes human speech in real time, monitors sensors and modifies programs based on their input in real-time, or controls other devices, again in real-time, this is something which simply could not be done before. So while it is important to remember that, on one level, a modern digital computer is just a faster calculator, we should not ignore its other identity: that of a cybernetic control device. To put this in different way, while new media theory should pay tributes to Alan Turing (◊03), it should not forget about its other conceptual father—Norbert Wiener (◊04).

7 New Media as the Encoding of Modernist Avant-Garde; New Media as Metamedia

The approach to new media just discussed does not foreground any particular cultural period as the source of algorithms that are eventually encoded in computer software. In my article "Avant-Garde as Software" I have proposed that, in fact, a particular historical period is more relevant to new media than any other—that of the 1920s (more precisely, the years between 1915 and 1928).[6] During this period the avant-garde artists and designers invented a whole new set of visual and spatial languages and communication techniques that we still use today. According to my hypothesis,

> With new media, 1920s communication techniques acquire a new status. Thus new media does represent a new stage of the avant-garde. The techniques invented by the 1920s Left artists became embedded in the commands and interface metaphors of computer software. In short, the avant-garde vision became materialized in a computer. All the strategies developed to awaken audiences from a dream-existence of bourgeois society (constructivist design, New Typography, avant-garde cinematography and film editing, photo-montage, etc.) now define the basic routine of a post-industrial society: the interaction with a computer. For example, the avant-garde strategy of collage reemerged as a "cut and paste" command, the most basic operation one can perform on any computer data. In another example, the dynamic windows, pull-down menus, and HTML tables all allow a computer user to simultaneously work with practically unrestricted amount of information despite the limited surface of the computer screen. This strategy can be traced to Lissitzky's use of movable frames in his 1926 exhibition design for the International Art Exhibition in Dresden.

The encoding of the 1920s avant-garde techniques in software does not mean that new media simply quantitatively extends the techniques which already existed. Just as it is the case with the phenomenon of real-time computation that I discussed above, tracing new media heritage in the 1920s avant-garde reveals a qualitative change as well. The modernist avant-garde was concerned with "filtering" visible reality in new ways. The artists were concerned with representing the outside world, with "seeing" it in as many different ways as possible. Of course some artists already began to react to the emerging media environment by making collages and photo-montages consisting of newspaper clippings, existing photographs, pieces of posters, and so on; yet these practices of manipulating existing media were not yet central. But a number of decades later they have moved to the foreground of cultural production. To put this differently, after a century and a half of media culture, already existing media records (or "media assets," to use the Hollywood term) become the new raw material for software-based cultural production and artistic practice. Many decades of analog media production resulted in a huge media archive and it is the contents of this archive—television programs, films, audio recordings, etc.—which became the raw data to be processed, re-articulated, mined and re-packaged through digital software—rather than raw reality. In my article I formulate this as follows:

> New media indeed represents the new avant-garde, and its innovations are at least as radical as the formal innovations of the 1920s. But if we are to look for these innovations in the realm of forms, this traditional area of cultural evolution, we will not find them there. For the new avant-garde is radically different from the old:
>
> 1. The old media avant-garde of the 1920s came up with new forms, new ways to represent reality and new ways to see the world. The new media avant-garde is about new ways of accessing and manipulating information. Its techniques are

hypermedia, databases, search engines, data mining, image processing, visualization, and simulation.

2. The new avant-garde is no longer concerned with seeing or representing the world in new ways but rather with accessing and using in new ways previously accumulated media. In this respect new media is post-media or meta-media, as it uses old media as its primary material.

My concept of "meta-media" is related to a more familiar notion of "postmodernism"—the recognition that by the 1980s the culture became more concerned with reworking already existing content, idioms and style, rather than genially creating new ones. What I would like to stress (and what I think the original theorists of post-modernism in the 1980s have not stressed enough) is the key role played by the material factors in the shift towards postmodernist aesthetics: the accumulation of huge media assets and the arrival of new electronic and digital tools which made it very easy to access and re-work these assets. This is another example of quantity changing into quality in media history: the gradual accumulation of media records and the gradual automation of media management and manipulation techniques eventually recoded modernist aesthetics into a very different postmodern aesthetics.

8 New Media as Parallel Articulation of Similar Ideas in Post-WWII Art and Modern Computing

Along with the 1920s, we can think of other cultural periods that generated ideas and sensibilities particularly relevant to new media. In the 1980s a number of writers looked at the connections between Baroque and post-modern sensibilities; given the close link between post-modernism and new media I just briefly discussed, it would be logical if parallels between the Baroque and new media can also be established.[7] It can also be argued that in many ways new media returns us to a pre-modernist cultural logic of the eighteenth century: consider for instance, the parallel between eighteenth-century communities of readers who were also all writers and participants in Internet newsgroups and mailing lists who are also both readers and writers.

In the twentieth century, along with the 1920s, which for me represents the cultural peak of this century (because during this period more radically new aesthetic techniques were prototyped than in any other period of similar duration), the second cultural peak—the 1960s—also seems to contain many of new media's genes. A number of writers such as Söke Dinkla have argued that interactive computer art (from the 1980s on) further develops ideas already contained in the new art of the 1960s (happenings, performances, installation): active participation of the audience, an artwork as a temporal process rather than as a fixed object, an artwork as an open system.[8] This connection makes even more sense when we remember that some of the most influential figures in new media art (Jeffrey Shaw, Roy Ascott (◊10)) started their art careers in the 1960s and only later moved to computing and networking technologies. For instance, at the end of the 1960s Jeffrey Shaw was working on inflatable structures for film projections and performances which were big enough to contain a small audience inside—something which he later came back to in many of his VR installations, and even more directly in the EVE project.[9]

There is another aesthetic project of the 1960s that also can be linked to new media not only conceptually but also historically, since the artists who pursued this project with computers (such as Manfred Mohr) knew of minimalist artists who during the same decade pursued the same project "manually" (most notably, Sol LeWitt).[10] This project can be called "combinatorics."[11] It involves creating images and/or objects by systematically varying a single parameter or by systematically creating all possible combinations of a small number of elements.[12] "Combinatorics" in computer art and minimalist art of the 1960s led to the creation of remarkably similar images and spatial structures; it illustrates well that the algorithms, this essential part of new media, do not depend on technology but can be executed by humans.

Four Decades of New Media

Along with the ones I already mentioned, more connections between 1960s cultural imaginations and new media exist. As with another recent important anthology on new media (Randall Packer and Ken Jordan's *Multimedia: From Wagner to Virtual Reality*), *The New Media Reader* contains a number of important texts by the radical artists and writers from the 1960s which have conceptual affinity to the logic of computing technology: those of Allan Kaprow (◊06), William Burroughs (◊07); the Oulipo (◊12) (whose members pursued the combinatorics project in relation to literature), Nam June Paik (◊15) and others. Section I, "The Complex, the

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Changing, and the Intermediate" and section II, "Collective Media, Personal Media," present what is to date the most comprehensive set of cultural texts from the 1960s. These ideas particularly resonate with the developments in computing in the same period.

Although modern computing has many conceptual fathers and mothers, from Leibnitz to Ada Lovelace, and its prehistory spans many centuries, I would argue that the paradigm that still defines our understanding and usage of computing was defined in the 1960s. During the 1960s the principles of the modern interactive GUI were given clear articulation (although the practical implementation and refinement of these ideas took place later, in the 1970s at Xerox PARC). The articles by Licklider (◊05), Sutherland (◊09), Nelson (◊11, ◊21, ◊30), and Engelbart (◊08, ◊17) from the 1960s included in the reader are the essential documents of our time; one day the historians of culture will rate them on the same scale of importance as texts by Marx, Freud, and Saussure. (Other key developments that also took place in the 1960s and early 1970s were the Internet, Unix, and object-oriented programming. A number of other essential ideas of modern computing such as networking itself, the use of computers for real-time control, and the graphical interactive display were articulated earlier, in the second part of the 1940s and the first part of the 1950s.)[13]

The first two sections of the reader take us into the end of the 1970s; during the time period covered in section II the key principles of modern computing and the GUI had already been practically implemented and refined by the developers at Xerox PARC but they were not yet commercially available to consumers. The third section, "Design, Activity, and Action," runs from the end of the 1970s into the 1980s. Near the end of this period the Macintosh (released in 1984) popularized the GUI; it also shipped with a simple drawing and painting programs which emphasized the new role of a computer as a creative tool; finally, it was the first inexpensive computer which came with a bit-mapped display. Atari computers made computer-based sound manipulation affordable; computer games achieved a new level of popularity; cinema started to use computers for special effects (*Tron*, released by Disney in 1982, contained seventeen minutes of 3-D computer generated scenes); towards the very end of the decade, Photoshop, which can be called the key software application of postmodernism, was finally released. All these developments of the 1980s created a new set of roles for the modern digital computer: a manipulator of existing media (Photoshop); a media synthesizer (film special effects, sound software); and a new medium (or rather, more than one new media) in its own right (computer games). *The New Media Reader* collects essential articles by computer scientists from the 1980s that articulate ideas behind these new roles of a computer (Bolt (◊29), Shneiderman (◊33), Laurel (◊38) and others).

As computing left the strict realm of big business, the military, the government, and the university and entered society at large, cultural theorists begin to think about its effects, and it is appropriate that *The New Media Reader* also reprints key theoretical statements from the 1980s (e.g., Sherry Turkle (◊34), Donna Haraway (◊35)). I should note here that European cultural theorists reacted to computerization earlier than the Americans: both Jean-François Lyotard's *The Post-Modern Condition* (1979) and Jean Baudrillard's *Simulacra and Simulations* (1981) contain detailed discussions of computing, something which their 1980s American admirers did not seem to notice.

The last section of the reader, "Revolution, Resistance, and the Launch of the Web" continues to weave texts by computer scientists, social researchers, cultural theorists, and critics from the end of the 1980s onward; it also takes us into the early 1990s when the rise of the Web redefined computing one again. If the 1980s gradually made visible the new role of a computer as a media manipulator and an interface to media—the developments which eventually were codified around 1990 in the term "new media"—in the 1990s another role of a digital computer (which was already present since the late 1940s) came to the foreground: that of a foundation for real-time multimedia networking, available not just for selected researchers and the military (as it was for decades) but for millions of people.

In the 1960s we can find strong conceptual connections between computing and radical art of the period, but with the sole exception of Ted Nelson (the conceptual father of hypertext) no computer scientist was directly applying radical political ideas of the times to computer design. In fact these ideas had a strong effect on the field, but it was delayed until the 1970s when Alan Kay (◊26) and his colleagues at Xerox PARC pursued the vision of personal computer workstation that would empower an individual rather than a

big organization. In the late 1980s and early 1990s, however, we seem to witness a different kind of parallel between social changes and computer design. Although causally unrelated, conceptually it makes sense that the end of Cold War and the design of the Web took place at exactly the same time. The first development ended the separation of the world into parts closed off from each other, making it a single global system; the second development connected world's computers into a single network. The early Web (i.e., before it came to be dominated by big commercial portals towards the end of the 1990s) also practically implemented a radically horizontal, non-hierarchical model of human existence in which no idea, no ideology, and no value system can dominate the rest—thus providing a perfect metaphor for a new post–Cold-War sensibility.

The emergence of new media studies as a field testifies to our recognition of the key cultural role played by digital computers and computer-enabled networking in our global society. For a field in its infancy, we are very lucky to now have such a comprehensive record of its origins as the one provided by *The New Media Reader;* I believe that its readers will continue to think about both the ideas in its individual texts and the endless connections which can be found between different texts for many years to come.

1. For a good example of cyberculture paradigm, see the Resource Center for Cyberculture Studies, <http://www.com.washington.edu/rccs/>

2. Lev Manovich, *The Language of New Media* (Cambridge: MIT Press, 2001).

3. I don't mean here the actual data structures and algorithms which may be used by particular software—rather, I am thinking of them in a more abstract way: what is the structure of a cultural object and what kind of operations it enables for the user.

4. Manovich, *The Language of New Media,* 80.

5. I believe that the same problems apply to Erkki Huhtamo's very interesting theory of media archeology which is close to the approach presented here and which advocates the study of tropes which accompany the history of modern media technology, both the ones which were realized and the ones which were only imagined.

6. Lev Manovich, "Avant-Garde as Software," in *Ostranenie,* edited by Stephen Kovats (Frankfurt: Campus Verlag, 1999). <http://www.manovich.net/docs/avantgarde_as_software.doc> (Quotations are from the online text.)

7. Norman Klein is currently completing a book entitled *From Vatican to Las Vegas: A History of Special Effects* that is discussing in detail the connections between the treatment of space in the Baroque and in cyberculture.

8. See for instance Söke Dinkla, "From Participation to Interaction: Towards the Origins of Interactive Art," in *Clicking In: Hots Links to a Digital Culture,* edited by Lynn Herhman Leeson (Seattle: Bay Press, 1996).

9. Jeffrey Shaw, ed., *Jeffrey Shaw—A User's Manual* (DAP, 1997).

10. Information on Manfred Mohr can be found online at <http://www.emohr.com/>.

11. Frank Dietrich has used the term "combinatorics"to talk about a particular direction in the early computer art of the 1960s. See Dietrich, Frank, "Visual Intelligence: The First Decade of Computer Art," Computer Graphics, 1985.

12. It is interesting that Sol LeWitt was able to produce works "by hand" which often consisted of more systematic variations of the same elements than similar works done by other artists who used computers. In other words, we can say that Sol LeWitt was better in executing certain minimalist algorithms than the computers of the time.

13. See Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge: MIT Press, 1997).