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# Computer art

The example of the Light-space modulator showed that computers are not necessary for unstable media to take artistic incarnations. However, computers are one of the main mediums in which unstable media takes an aesthetic side.

<note on coda>

## The digitalisation of life

From the beginning of robotics and artificial beings, there has been the assumption that humans are at a higher level than those artificial beings.

Consequently, when an A.I., robotics, software, hardware, or computers make a breakthrough in human-like behaviour, the question of whether the machine has become human arises.

We saw such a situation when AlphaGo cracked the game of G.O. (Khos 2017), or when an A.I. produced a piece of art that was sold for an exorbitant price (Christie's 2018), and the consequent articles on what this means for creativity, e.g. (Hyde 2022). In addition to this, we see that most literature and films present a future where machines are taking over results in the enslavement, or destruction, of humans.

These situations are based on the Anthropocene way of thinking (Most 2020), where humans are on top and everything in the ecosystem is there to serve them. However, we could also drop the human-centred perspective and take a flat ontology perspective where there is no hierarchical relation where humans are on top of all the other entities in the ontology (Braidotti en Hlavajova 2018, 296).

In this perspective, asking whether the machine has become human is the wrong question. We should instead ask, how artificial or mechanical have humans become?

Media theorist Marshall McLuhan argues that technological development are extensions of our humanity (McLuhan and McLuhan 1988). For example, a car is an extension of mobility capabilities. Computers enhance our calculation speed and the information we can retrieve and store. A significant difference between the computer and other media is that it can transform any medium into any other medium (McLuhan and McLuhan 1988). This has given rise to a hypermediality in the way we perceive the world; McLuhan refers to this as the acoustic space; in his words:

*“… with the rise of radio, television, the world wide web, and new media in general, a big flip took place in our time. This is the changeover from the eye to the ear. Most of us, having grown up in the visual world, are now suddenly confronted with the problems of living in an acoustic world which is, in effect, a world of simultaneous information. The visual world has very peculiar properties, and the acoustic world has quite different properties. The visual world which belongs to the old nineteenth century, and which had been around for quite a while, say from the sixteenth century anyway, has the properties of being continuous and connected and homogeneous, all parts more or less alike. Things stayed put. If you had a point of view, that stayed put.*

*The acoustic world, which is the electric world of simultaneity, has no continuity, no homogeneity, no connections, and no stasis. Everything is changing. To move from one of those worlds to the other is a very big shift. It’s the same shift that Alice in Wonderland made when she went through the looking glass. She moved out of the visual world and into the acoustic world when she went through the looking glass”.* (McLuhan 1970)

The exponential development of microprocessors in the last few decades has significantly shifted our understanding and interaction with digital tools. Flusser argued that the Romanian revolution, occurring during his time, was a mediated revolution (Flusser 1990), making it an extraordinary event. However, contemporary events like the Ukraine-Russia and Israel-Hamas conflicts illustrate that what were once considered extraordinary happenings have become commonplace. Notably, depending on one's physical side of the conflict, media and technology will influence and manipulate our notions of morality and self, our superego and ego, shaping our perception of identity.

As a personal example, in the era before smartphones, navigating from point A to an unfamiliar point B would involve using a map or asking for directions, requiring basic skills like remembering telephone numbers. Nowadays, attempting to find my way to an unknown location without Google Maps on my smartphone induces stress, and there's a risk of getting lost. In my case, various technological augmentations, such as my phone and computer, have become indispensable. While not physically embedded in my organic body (yet), they have become integral for me to function effectively in contemporary society.

### Of Ghosts and Shells

Another crucial aspect tied to the rise of hypermediality in shaping our perception of the world is that the term "world" is no longer confined solely to the "physical world." The advent of hypermediality is that we now have alternative "digital worlds" where individuals can establish a distinct existence and identity. In the well-acclaimed film Ghost in the Shell (Oshii 1995), and the associated franchise, this duality is explored under the concepts of Ghost and Shell.

A Ghost can be compared to the Western concept of the soul. The main difference is that the soul belongs to the spiritual world, whereas a Ghost belongs to the world of science.

A Shell is a physical object that can host a ghost. For example, it can be a human body, an animal body, a cybernetic body, or a machine.

At the beginning of the first film, a Ghost is understood as what defines humans. In other words, the difference between a human and a robot is that the former has a Ghost, whereas the latter does not.

During the films, this concept of Ghost evolves to not being only a defining characteristic of humans but of living beings in general. That means that other non-human beings would also have a Ghost. Moreover, there can also be living beings that come into existence without a shell[[1]](#footnote-1).

A Ghost is what defines sentient beings and life in general. A Ghost retains its “humanity,” or living force, regardless of how much biological material is replaced by cybernetic parts. Since a Ghost is in the realm of science, it can be transferred from one shell to another. It can also be hacked to make it believe it is something other than it originally was.

### We are all cyborgs…

In 1995, when the first Ghost in the Shell film was aired, these ideas were seen as Sci-Fi dissociated from physical reality. However, nowadays, my Facebook, Instagram, and LinkedIn profiles, digital data the government has collected, and many faces on the blockchain are essential to my identity beyond my physical body. Without them, I will be just a shell.

In this perspective, we could rephrase Dona Haraway’s discussion on companion species (Haraway 2003), and argue that technology has become, to me, a companion species. I spend more time with my phone than with my dog, and most of my interactions with other humans are mediated by technology.

The way we fuse with technology and the several identities this facilitates brings us back to the cyborg perspectives of Dona Haraway (Haraway 2015). Following her definition of a cyborg, I can say that I am a cyborg because I am a collection of individualities. I have my organic body, but I have a presence on Instagram, Facebook, DigiD, and several blockchains. I use several shells to exhibit part of my Ghost(identity).

The digitalisation of life does not stop on the individual. The international world order is witnessing the rise of another type of power beyond economic and military. Namely, the digital is also a dominant power in the international world order (Bremmer 2023). A good illustration of this is the US election of 2020, where technology companies took an active role in “saving the democratic process”. Important to notice here is that up until now, digital power structures have not been managed by governments but by private corporations[[2]](#footnote-2).

As humans, we are moving into posthumanism, where the organically physical body is no longer the gravitational centre but our fusion as one being with technology in the sea of information.

All this illustrates how computers are changing our reality in a boarder sense. We will now focus on how computers require a different perspective when creating art objects.

## Computer art vs Traditional art – Practical differences

Paul Valery, quoted by Walter Benjamin (Benjamin 1969), says: *“In all the arts there is a physical component which can no longer be considered or treated as it used to be, which cannot remain unaffected by our modern knowledge and power.”*

This section will discuss that physical component when computers are involved. In the later sections, we will discuss differences in the perception of traditional and digital aesthetic objects.

Computer art, or digital art, incorporates algorithms, digital technology, and computers in the creative process.

Matt Pearson, one of the precursors of the Processing language, sees it as follows: *“This revolution would be impossible without a new understanding of software as a cultural artifact. Where we once saw text processors as literal typewriter replacements, we now download and exchange apps as a popular pastime. Websites that used to be closed domains of proprietary information now sport public APIs, enabling professionals and enthusiasts alike to create ever popular “mashups” based on their data.*

*In the creative field, the most significant development is the realisation that software [and hardware] processes aren’t simply tools, but can become the very material from which works are made… …A new generation of electronic artists has turned to code as fertile ground for conceptual and formal experimentation, simultaneously providing a pragmatic framework for computational creativity and a theoretical context for the created artwork.”* (Pearson 2011, x)

### Three paradigm shifts

Another point to Pearson’s view is that already in the years 1960’s, artists were already using computers for creative purposes. Several shifts of paradigm have been needed for this to happen.

#### From static to dynamic objects

The first paradigm shift arises because working with a computer requires transitioning from viewing the art object as a static entity, detached from the artist and the viewer. Instead, a new perspective emerges, wherein the artwork transforms into a dynamic object that interacts with the artist and the viewer. Furthermore, technology facilitates a "conversation" involving the artist, the machine, and the evolving artwork within the creative process. This aligns closely with the principles outlined in the Unstable Media manifesto discussed in the previous section. The creation process and the artwork itself, under this paradigm, evolve into a cybernetic system where a feedback loop becomes an integral aspect of the piece. We will delve into this in more detail in the next section.

This means a different way of thinking is needed to make art with computers. As stated by Matt Pearson, *“With more traditional art forms—sculpture, painting, or film, for example—an artist uses tools to fashion materials into a finished work. This is clearly doing it the hard way. With generative art, the autonomous system does all the heavy lifting; the artist only provides the instructions to the system and the initial conditions. The artist’s role in the production process may be closer to that of a curator than a creator. You create a system, model it, nurture it, and refine it, but ultimately your ownership of the work produced may be no more than a parent’s pride in the work of their offspring.”* (Pearson 2011, 4)*.*

#### Technical craftsmanship in the praxis of artistic practice

This brings us to a second paradigm shift that relates more directly to the avantgarde perspective. Namely, the difference between the “digital artist” and the “software engineer” becomes very diffuse. This is very well aligned with the historical avantgarde movement of the Bauhaus that promoted the abolishment of differences between the artist and the artisan; in Walter Gropius's words, “The artist is an exalted artisan” (Gropius 1919). I would reformulate this by claiming that “the digital artist ought to be an exalted software engineer”.

A first argument on why artistic practice with computers requires a fusion between art and craftsmanship is that technology is not usually developed or designed for artistic purposes. We can argue that “art is mind over matter” (Mul 2018); because of this, using technology as an artistic medium requires the artist to have the craftmanship to hack the machine to do something it was not intended to do.

A second point is that generic tools for general artistic purposes like Processing, p5.js, or TouchDesigner are programming languages. Therefore, working with those needs the “artist” to learn to program with them. For example, Processing and p5.js are dialects of Java and JavaScript, respectively. Their syntax has been designed to be simple and accessible, making it suitable for those with little or no programming experience. They abstract many of the complexities of underlying programming language and are well suited for graphics and interaction tasks. However, even with those, there is no way around writing the code.

One may think that the “artist” could hire a “software engineer” to make programming. The problem here is that without the knowledge of “programming”, the artist can no longer modify the program. Hence, the artist must become skilful enough to express their vision in the system. An alternative to this is that the artist becomes part of a team that can do it[[3]](#footnote-3). This is already a switch from the view of the traditional artistic practice that places the “artist” as an isolated individual.

This argument still works for less code-intensive tools like Photoshop or Illustrator. The artist should be able to use the tool themselves and have enough knowledge of the process or tool to be part of a team producing the “art objects”.

The digital artist as an exalted software engineer also goes the other way around. Technically skilled people interested in the use of technology for creative purposes ought to realise that technical considerations are not necessarily the most important driver for digital creative practice. Given that the work will often be teamwork, communication and collaboration skills will be necessary for success. From my experience, I have met several technically skilled people with whom I cannot collaborate for artistic purposes because they find it difficult to compromise between technical correctness and collaboration over artistic purposes.

Timo Hoogland created a programming language, Mercury, to make music. He is actively promoting it is adoption to different audiences and describes the above point as follows: *“My workshops on Mercury are attended both by people from computer science backgrounds and music backgrounds. I have noticed that those from a computer background are very quick to grasp the syntax and technicalities of Mercury but have difficulties making music with it. It is musicians who can leave the technicalities aside and quickly start making music with it. Mercury was made to make music.”* (Hoogland 2023)

#### Embracing remediation

A third change in paradigm is that working with computers by nature implies mapping information from one format to another.

The following example presented by Marije Baalman (Baalman 2022) illustrates this:

*“A performer sits on stage, a cello in front of his body. With the bow, he plays a few tones, and now he takes the bow off the strings and just moves the bow in the air, transforming the sound that was just played; almost invisible to the audience, he uses his feet on pedals that are taped to the stage floor. The performer controls the moves of the bow in particular and expressive ways, as he listens attentively to the resulting sounds. Occasionally, he reaches out with his left hand to a side table, where he moves some knobs or sliders, or presses a button. Alternating between playing sounds on the cello, moving the bow, and pressing the pedals, he builds up several layers of sound that together form a melodic and rhythmical structure. As an audience member it is fascinating to watch Andi Otto play his Fello. The type of music that Andi Otto produces is often performed from behind a table, with a performer staring at a laptop computer screen. But with the Fello, you can see how the music is created: what the source of the sound is, and how it is manipulated and modulated into electronic sound with a very organic feel to it. The worlds of the cello and of dub music meet as Andi is transforming the sound of the cello with the bow.”* (Baalman 2022, 19)

Marije Baalman points out that in the piece above, there is a mapping that is essential to interactive work. I add to this by saying this mapping is essential to digital works. In terms of modern media theory, this can be rephrased by saying that remediation is inherent to working with computers. More on the conceptual implications of this in later sections.

In (Baalman 2022) Marije Baalman illustrates a general pattern for the mappings involved as follows:

* A gesture is performed in the environment.
* This is captured by a sensor that translates the gesture into an electronic signal.
* The signal is processed by an electronic circuit, often to digitise it.
* Next, the signal enters some sort of computational model that translates the data into parameters.
* These parameters control an output medium such as sound, light, video, or mechatronics.

*“At each step in the process, there is a translation or a mapping problem: how is the output of one step connected to an input of another step? What happens inside each step? Of course, this is a simplification of the steps involved, and there are many variations possible of this general scheme.”* (Baalman 2022, 25)

A more straightforward example, in the creative coding field, is when written code is compiled and an image appears on the screen. Here, we can send the “image” to a printer to make a physical version of it. Here are three remediations. In the last one, we all have witnessed that this data transformation can often produce unexpected results that interfere with the creative process or production. More complex or less orchestrated remediations like the ones listed above require the digital artist's full attention.

From my personal experience, in my work “Digital Presence” (2023), I aimed to capture visitors’ heartbeat in one station and transmit it to other station so that they could feel a physical sensation of the digital presence of others. Although conceptually simple, managing the remediation of the different data points and ensuring it kept working was far from trivial. After several tests and preparation, it failed in the final presentation.

This is to illustrate that in digital works, even if you take care of how your data is being mapped and believe it is under control, it may come back to haunt you.

Since the flow of data in digital works is usually continuous, digital art requires the artist to embrace those changes.

[add example with Chagall]

### Illustration Vera Molnar – from the imaginary machine to the real machine

Here, I will illustrate the points of the previous section with the work of Vera Molnar, one of the pioneers of computer art[[4]](#footnote-4).

Vera Molnar is a Hungarian French artist known for her contributions to the field of digital art and algorithmic art. She was born on January 5, 1924, in Budapest, Hungary, and studied painting at the Budapest School of Fine Arts. Then, she moved to Paris, where she developed most of her practice.

Despite the social context in which she was educated, Vera Molnar wanted to be an abstract painter. In her own words, *“If I can describe myself, I am a painter, an image-maker of images of a non-figurative kind. I 'create' visual forms in the sense that they consist of combinations of shapes that cannot be found in nature”* (Molnar, Toward Aesthetic Guidelines for Paintings with the Aid of a Computer 1975)

She followed the constructivist tradition. She was not interested in grand concepts but in simple principles and rules that would reveal unexpected beauty. In her words: *“My life has been about squares, triangles, and lines. In this sense, I do not start from grand concepts that create patterns but rather from simple principles and rules and by introducing small variations undisclosed beauty appears”* (Riagamonti and Kennedy 2018).

This is well illustrated with one of the most recognisable works by Vera Molnar, “Structure des Quadrilaters” (year?).

<image>

The first thing to notice is that “Structure des Quadrilaters” is a series of works with many variations over the years. The key point is that the core principle, or process, in all the instances of the series is the same (Molnar, Toward Aesthetic Guidelines for Paintings with the Aid of a Computer 1975, 188):

* Drawings start from an initial square array of like sets of concentric squares.
* By making variations on the variables, a “conversation” between the Author and the computer takes place.In thecase of this work, the available variables are:
  1. *The number of sets,*
  2. *the number of concentric squares within a set,*
  3. *the displacement of individual squares,*
  4. *the deformation of squares by changing angles and lengths of sides,*
  5. *the elimination of lines or entire figures and*
  6. *the replacement of straight lines by segments of circles, parabolas, hyperbolas, and sine curves.*

Thus, a great variety of images can be obtained from an initial grid. In this description, we can see that “Structures des Quadrilaters” is not a fully static object but has a dynamic component which will result in different physical “aesthetic objects” that the artist could not foresee from the beginning.

In (MuDA 2019) she mentions how computer-generated randomness can be a replacement for intuition to make interesting art. This leaves even more room for undiscovered possibilities and adds to the dynamicity of her works.

[add some pictures and perhaps some code]

Something to point out here is that in the time of Vera Molnar, graphic interfaces were not as well developed as they are now. Her early works were mostly done on plotter machines. Therefore, after she had written the code, she had to wait for the machine to reinterpret into a print on the paper. That is, remediation was at the core of her practice.

“Structure des Quadrilaters” is an example of her process. She describes her creative process more generally as follows:

*“Whenever I begin a picture, I have an initial idea of it in mind. The procedure that I use to arrive at the final work, to be described below, is tedious if carried out by hand. Furthermore, the final picture rarely corresponds to my initial idea of it.*

*I develop a picture by means of a series of small probing steps, and each step is followed by evaluation. In my opinion, painters should employ such a procedure, especially if they consciously wish to learn what kind of aesthetic importance is occurring on the canvas as the painting develops and what effect the work may have on viewers. Making a series of pictures that are alike except for the variation of one parameter is not uncommon”* (Molnar, Toward Aesthetic Guidelines for Paintings with the Aid of a Computer 1975, 186)

Paraphrasing (Nierhoff 2018), a more detailed way to describe Vera Molnar's process would be as follows:

She will set up a set of rules, follow them, and modify the rules according to the results. Before she had access to computers, she would become an *“imaginary machine”* for which she would execute the rules and make the results.

However, as pointed out by Vera Molnar in (Molnar 1975), this stepwise procedure has two essential disadvantages if carried out by hand. Above all, it is tedious and slow. To make the necessary comparisons in a developing series of pictures, one must make many similar ones of the same size and with the same technique and precision. Another disadvantage is that, since time is limited, one can consider only a few of many possible modifications. Furthermore, these choices are influenced by disparate factors such as personal whim, cultural and educational background, and ease of execution.

When she was able to get access to a computer in 1968 (Nierhoff 2018, 6), her “imaginary machine” became a “real machine”. She described this change as follows: *“The computer, with its unmanageable potential of image variations, is an optimal device. When it comes to digital images, the absence of their seclusiveness accom­modates the artist’s experimental scientific approach because, behind the single picture, there is always the image category that also needs to be considered. By means of random generators, chance can introduce interference into the program at various stages. As a consequence, new variations can be continuously calculated and real­ized as images. The selected images thus constitute only limited material expressions of a virtually infinite consec­utive chain.”* (Nierhoff 2018, 10)

Notice how Vera Molnar talks about a “conversation” between her and the machines in these citations. This aligns with the avantgarde thinking of Maholy-Nagy we discussed in previous sections.

On the view of software development in the praxis of artistic life, Vera Molnar thought that... *“…the computer, on its own, does not have the capacity to create art, however: it is a very good assistant, but it is a little bit stupid, a lot must be explained to it.”* (Nierhoff 2018, 7). However, she recognises that the computer was often more innovative than what she, or humans, could achieve *“Time and again, I have compared both forms of chance, one generated by me and the other resulting from mathematical probabilities, only to realise that my self-generated chance was much less innovative”* (Nierhoff 2018, 9).

She embraced the use of computers also to conceptualise her art practice: *“Thanks to computers, the concept of form, in the broader sense, could be reduced to a lack of randomness with an organised set of elements”* (Molnar en Molnar 1989)

Aligning to the avantgarde principles, she also does not ignore the position of art in society. She rejects the autonomy of art *“I do not make drawings and paintings with the aid of a computer solely for personal satisfaction; I hope that others will also enjoy them. I do not agree with the notion of art for art's sake and of science for the sake of science. Sartre convincingly explains why this notion is untenable. I, personally, know of no artist who refuses to let people see his work. On the other hand, I do not believe that an artist should go to the extreme of ignoring his own taste and convictions in order to please others. There should be an intermediate ground where aesthetic satisfaction is experienced mutually.”* (Molnar 1975, 189)

All this illustrates the three paradigms shift of working with computer art together with the relation to the avantgarde movements.

1. The core of plot of the first film is that a Ghost with no Shell was born on the “sea of information”. In the film it is called the Puppet Master or Project 2501. In the film, Project 2501 is a sentient being with enough consciousness to communicate with humans, seek political asylum, and aim for evolution to transcend its existence. [↑](#footnote-ref-1)
2. The idea of corporations ruling the world has been present in the Cyberpunk literature since its beginning. However, reality has shown that governmental organizations and policies lag behind technological developments. [↑](#footnote-ref-2)
3. In the software development industry, software is developed by teams. In fact, contemporary software development methodologies (Agile) foster the success and results as a team achievement over individual achievements. [↑](#footnote-ref-3)
4. Some may differ whether Vera Molnar is really one of the pioneers of computer art but since I do not want to not encourage the male dominated culture on art and its institutions, I will Illustrate the thinking behind computer art with her work. [↑](#footnote-ref-4)