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Artworks

Performances

Foreword

Is art political? If so, is it so all the time, intrinsically and thus, inevitably? Or is the relation between art and politics more a matter of contingency, so that one is still allowed to imagine a cultural safe haven where aesthetic experiences are meaningful just because they free the viewer from the weight of the world and allow them to float, at least for some time, in a bubble of soothing perceptions? Whatever the nature of the entanglements between art and politics, 2024 is definitely not the right time to use the former as a refuge from the latter since, whether we like it or not, politics is taking center stage in every possible news cycle, to avoid which we should quite literally live under a rock.

Major elections around the world have taken, are taking, and will take place during this year: in Indonesia, in India, in the EU for the European Parliament and, of course, in the United States of America. All this is happening against the backdrop of the ongoing conflicts in Ukraine and in Gaza, whose developments are tightly connected to the results of many of these elections, in terms of foreign policy, international allegiances, and military expenditures prospected by the winning parties.

To state that we have never experienced so many terrible wars at the same time is not accurate, nor is the very Euro-centric claim that war has never been so close to home since World War II. In the very decade preceding the events of 9/11, which are now commonly taken as the starting point of this era of international turmoil and instability, the world was marred by the Gulf Wars, the Rwandan Civil war, the beginning of the still ongoing Somali Civil war and, very close to the geographical center of the European continent, the Balkan wars.

If a difference is to be found between those conflicts and what is happening today, it is arguably in the role played by computing technology, although determining the key factors is not straightforward. Indeed, the relation between computers and war is as old as computers themselves and is nothing new: not only those considered among the founding fathers of computer science, like Von Neumann and Turing, have played important roles in World War II, but even seemingly harmless inventions like the rotating sphere of a mouse, universally attributed to an American initiative in the 1960s, can be traced back to military experiments by the British and the Canadian Navy in the 1940s. Surely the latest advancements in Artificial Intelligence are increasing the importance of the role of automation in warfare, in terms of which side has the technological leading edge and can elude defenses, strike first, and in a more devastating way but, apart from the dizzying figures concerning the numbers of sensors, processors, and computed operations involved in these endeavors, the discourse is essentially the same as those comparisons that were drawn between speeds of fighter jets or ranges of missiles in the 20th century.

What is truly different today is the way conflicts are reported to the audience and the larger and larger contribution of digital technologies to such reports. On the one hand, the spread of telecommunication networks and devices allows for a quantity and precision of news

that is bewildering, especially to those who have memories of radio news during World War II: some 80- and 90-year-olds still cannot wrap their heads around hearing the exact number of persons and how many children among them were wounded on a particular day in a specific area in Ukraine or Gaza. Computers, in all their forms, have certainly transformed war journalism for good. However, on the other hand, digital elaboration and transmission of data is also open to manipulation, which shows the darker side of the power of this kind of technology.

In this digitally enhanced environment, audiences are driven to question the accuracy of the media they consume, particularly with the rise of Generative AI, which has further complicated perceptions of reality through the creation of deepfakes. The term "deepfake'' does not refer to the seriousness of the deception, but rather to the multiple layers of artificial neurons in the neural networks involved in the production of content. These deepfakes represent a powerful form of rhetorical manipulation and are already seen as pivotal in a new type of conflict that extends beyond traditional cyber warfare. Given that many people now rely on social media as their primary news source and given the very loose control over content authenticity on such platforms, this is referred to as a "post-truth" war. Currently, deepfake technology is highly advanced but still detectable by well-trained neural networks. This has led to an arms race among Generative AI users, with efforts focused on creating deceptive content on one side and detecting it on the other. We may chuckle at a presidential candidate using deepfake technology to depict himself in a friendly conversation with a group of individuals from a population segment that he has allegedly been neglecting, but when news agencies start using stock images from sources that are relying on AI technology to enrich their image repositories, mixing real photos with photos that look realistic but are not real, then we really are already in a post-truth era.

In this sense, one of the most famous and controversial works by world-renowned photographer Oliviero Toscani, co-founder of Fabrica, our gracious host organization, stands in the starkest contrast to all the issues described so far. In an era when airbrushing was done with a fine spray of paint, Toscani used an analog photograph of blood-stained and bullet-holed t-shirt and trousers which belonged to a Bosnian soldier killed in action during the Balkan wars. No digital manipulation, no head-spinning quantities of data for training or statistics: just the vestiges of the brutal end of one person. Since this image was used for a marketing campaign for an internationally known clothing line, detractors had it easy in criticizing the image, with accusations of sensationalism and spectacularization of the war for commercial purposes. Business was surely involved, but the cultural impact of that image was undeniable.

We are not assuming a neo-Luddite position here: we are not calling for a cessation of the use of digital technology or a moratorium on Artificial Intelligence. What we want to shed light on is the increasingly ambiguous role that digital devices and infrastructures are assuming in our lives, especially during these times of global upheaval. Circling back to our first question, if it is not at all easy to answer whether art is political or not, given the controversy-laden nature of computers when it comes to the reality of our opinions, stances, and truths, we may even more worriedly ask: Is computer art perhaps inevitably political? And what kind of politics are we talking about? The politics of the aggres-

sors in the post-truth wars of alternative facts and mirror worlds? Or the politics of those who are trying to defend the truth, whatever such truth might be, in a world where all opinions are valid?

Using digital technology for ethical purposes is a noble enterprise, although a very challenging one, not only because abuses with computers are happening in front of our very eyes and show how easy it is to fall into the traps of feeding the very systems we are trying to withstand, but also because values are such complex and abstract concepts that they require constant reevaluations, discussions, and compromises on our behalf. Ideas like democracy, justice, empathy are very difficult to capture with algorithmic devices that crunch and exchange 0s and 1s.

Computers, however, do not work in isolation: not only they must be part of a network to be able to transmit and receive data for better or worse, but humans must be there to build them, program them and, most importantly, give meaning to those data. Every meaningful fact happens in a context and since we are the creators of such context, this is where we should focus most of our efforts. Even Toscani's photo of a bloody t-shirt wouldn't have been anything more than a gross poster, hadn't it been accompanied by its relevant and tragic context.

This is why we couldn't be prouder to present to you all the papers, artworks, performances and research proposals for xCoAx 2024 enclosed in this book of proceedings: these works are proof that there are people out there who are willing and able to take up the challenge of diving into digital technology and make the best out of it, with results that are not simply beautiful or pleasing to the eyes and the ears, but a rich, meaningful, and deep embodiment of the convergence between aesthetics and ethics. We are very grateful to all our authors, artists, and researchers for giving us hope.

Peace.

X

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Eternal, Data, Decay

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The theory proposed in this paper suggests that the pursuit of immortality is a significant motivator behind the development of digital data technologies. Data storage is viewed as eternal, as the information itself does not decay. Although the hardware that contains the data may decay, the information can remain immortal due to lossless duplication. This characteristic of digital technology provides significant advantages and is a key factor in the success of information technology. However, the idea of data as eternal creates social and natural fallacies based on a simplistic model of knowledge as storage. Memory is more than bytes on a silicon chip. Generalization, abstraction, and forgetting are key components of thinking. It is argued that a new concept and model of data will be necessary for a sustainable and socially responsible collective future.

1. Save for Later

Attending a concert in the 21st century can often be an unsettling experience. Instead of thoroughly enjoying and immersing themselves in the music, many people remain still, holding up smartphones to record the performance. This reduces the bodily experience to an unsteady tripod recording, which cannot capture the essence of the performance. It is not just concerts but all kinds of events where such behavior is becoming the norm. The ‘save for later’ approach is becoming standard (Tamir 2018). It is still being determined if anyone will ever watch those shaky videos with poor audio. In the 21st century, humans have willingly transformed into data-gathering devices, contributing to global-scale database structures. There is an inner urge to capture moments rather than experience them, which is not limited to mobile device cameras. Global web companies track every move of our mice and trackpads, including each scroll and pause (Wolfie et al. 2017). Data collection has become habitual (Chun 2016). Global web companies track every movement of our computer input devices, including mice, trackpads, and gestures. This includes tracking scrolling and pauses. Gathering data has become the lifestyle of the 21st century. This data is used to train machine learning algorithms mimicking our behavior. From image tagging and text translation to content generation, machines are made to behave in forms similar to the data gathered by/through us.

The urge to “save for later” to record the most mundane things is a fascinating question (Sparrow et al. 2011), but what interests this paper most is the discrepancy between the model of digital data and the world we inhabit. As any human reading this text knows, we are all getting older. At some point, wrinkles appear, hair grows thinner, exercise

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becomes more difficult, and memory fades. The same is true of every pair of shoes I have ever owned: traces of time are inevitable. Everything grows and decays: A tree sprouts leaves; they grow and wilt in the fall, starting a cycle of growth and decay again. The pre-digital photos of your childhood show the signs of time as the colors slowly desaturate and a faint, ever-increasing yellow haze develops. Over millions of years, pressure, temperature, and chemical reactions have transformed sand into stone. Nothing is permanent; everything is in flux, always.

However, data as transmittable and storable computer information (etymonline 2024) is not conceptualized in this way: Data has a binary concept of decay, i.e., it is or it is not, and the transition between these two states is almost non-existent. Data centers are like cold storage houses for fruit or old books, where the hardware slowly decays over time, but the content, the data, does not decay in the same way. The distinction between hardware and software, between the physical and the digital, or between the medium and the message conceptualizes data as immortal (Rothblatt 2014). While errors occur when DNA is copied from one cell to another, copying data from one storage device to another is error-free in most cases. The process of lossless copying allows computational data to be conceptualized as eternal. Or as written in the journal Science by Marcia McNutt, “data are forever” (2015). Its immortality may be why humanity is so attracted to it: the “later” in “save for later” is attached to the promise of eternity (Fawns 2011; Kurzweil 2024).

As your favorite musician ages, retires, or dies, the shaky video footage recorded on your cell phone and stored in a network of global data centers will continue to exist, unaffected by the mechanisms of aging to which everything else in the world is subject. Data survives death by making lossless copies of itself. Of course, this is not entirely true: codecs change, data is deleted, and storage devices break. Keeping computer data intact is hard work. But what makes data unique compared to everything else is that data does not decay. As long as I can open it and it is not deleted, a digital image will stay the same. It will not turn yellow; the colors will not slowly desaturate and fade. The software part of the dual hardware/software divide will remain as long as it exists. The binary underpinnings of computation also determine the concept of data storage — data either is or is not.

2. Fallacies of Data

One can easily argue that the conceptualization of digital data as immortal is one of the greatest advances: its lossless reproducibility and its capabilities as a non—decaying storage medium are vast improvements in a world where everything else will sooner or later succumb to the laws of entropy. —A world in which the characters in older Wikipedia articles would slowly fade, or web pages would turn yellow if not constantly updated is, after all, a strange thought experiment. But to some extent, this is happening: website links are constantly disappearing (Bowers 2021; Garber 2013), a phenomenon called link rot, and if I don’t constantly update my devices with the latest software, these systems will become unusable (Chun 2016). However, the mode at play here is different: code can be read by a system or not.

In the spring of 2022, a group of researchers at the ZKM (Center for Art and Media, Karlsruhe, Germany) attempted to restart one of the earliest computers, the Zuse Z22, with serial number 13. This computer,

developed in 1957 by Konrad Zuse and chief designer Lorenz Hanewinkel, uses 415 vacuum tubes (ZKM 2024).; 65 years after its development, running the software on the hardware proved to be a laborious task. The difference that fascinates me is that once the software runs, it runs just as it did in 1957. While photographs from that time, stored on analog photographic paper, will show signs of decay, the software code remains unaffected by time. Computer systems are fragile. However, the underlying concept is different from that of decaying entities. In the next three sections, I want to explore three perspectives on why such a concept of data might be problematic. There are social, climatic, and conceptual reasons why it makes sense for everything in the world to be in flux. The concept of data as eternal, as a non-decaying entity, may not always be favorable.

2.1 Social Aspects

Over the past four decades, the Internet has undergone a profound transformation, evolving from its origins in military and research applications to become a pervasive global phenomenon that has shaped and continues to shape almost every aspect of human life (Castells et al. 2014). With its transition to a mass medium, storage capabilities and content changed dramatically. In particular, the emergence of large online platforms, credit reporting agencies, and consumer data brokers has given rise to companies with extensive knowledge about a large portion of the world's population (Wolfie et al. 2017). Some research suggests that social media companies can judge a user's personality better than close relatives or friends based on the data these companies collect (Youyou et al. 2015). Furthermore, advances in machine learning are leading to troubling new search engines that can find photos of a person based on a single image (Hill 2022). Often, as I have experienced myself, the results of such searches include images unknown to you. The scope and magnitude of the societal changes resulting from individual data collection cannot yet be fully grasped. We live in an era of gambling with the concept of privacy, and it is unclear who will win and who will lose in this game.

The European Union and countries like Argentina and the Philippines have introduced right-to-be-forgotten laws. These laws are intended to prevent stigmatization based on past actions (Mantelero 2013). However, these laws raise several issues and questions: One concern is where to draw the line between the right to be forgotten and freedom of speech (Solove 2003; Mayes 2011); the executive director of the Wikimedia Foundation, Lila Tretikov, has criticized the EU for punching holes in free knowledge (Tretikov 2014); another is technical implementation: Because digital data is so easy to copy, it is difficult to contain its spread. In sociology, this is known as the Streisand effect, meaning that the containment of information - in this case, an image of Barbra Streisand's Malibu home - has the unintended consequence of increasing awareness and, thus, spreading that very information. The difficulties of "digital forgetting" place a burden on individual victims, as illustrated in a 2019 New York Times article on online child abuse content (Keller et al. 2019): Digital images remain online forever, as long as they are duplicated and stored in various online locations. Even in the illegal case of child abuse content, the right to be forgotten seems impossible to enforce. Social media and cloud storage companies are

caught between discovering these images and protecting the privacy of their customers. The digital notion of immortal data creates conflict and suffering on a social scale. The digital idea of lossless reproduction of information leads to a world in which specific actions that are destructive on a personal level are virtually perpetuated.

2.2 Ecological Aspects

The metaphor of the cloud in 'cloud computing' and 'cloud storage' is ill-defined: clouds of frozen or liquid droplets suspended in the atmosphere have little to do with the server systems that enable planetary-scale networked computing. While the floating water particles and resulting rain make life on Earth possible, cloud storage is becoming one of the planet's most energy-intensive and destructive industries. In 2007, the average data center consumed as much energy as 25,000 homes (Kaplan 2008). Over the past decade, this consumption has increased dramatically and shows no sign of slowing in the 2030s.

Similarly, the web metaphor draws on the image of almost invisible silk-based spider webs. The web metaphor suggests lightness, transparency, extraordinary stability, and a state of floating in the sky. By 2019, approximately 20 billion devices will be connected to the Internet. Predictions estimate a doubling from 20 to 40 billion devices by 2025 (Vailshery 2022). In 1987, traffic to and from data centers was about two terabytes, twice the size of the hard drive on which this text is written. By 2007, that number had grown 250 million times to 50 exabytes. 2017, that number reached 1.1 zettabytes (a 10 with 21 zeros). In 2017, data centers consumed an estimated 200 terawatt-hours per year or about 1% of the world's electricity. They contributed about 0.3% of total carbon emissions (Jones 2018), and these numbers are expected to double by the 2020s.

In 2018, a study by OpenAI predicted that the electricity needed to train state-of-the-art machine learning models would double every 3.4 months (Amodei & Hernandez 2018) and that training GPT-3, a deep learning model for producing human-like text, would consume an estimated 1,404 megawatt-hours in 2020. Cryptocurrencies, like artificial intelligence, are marketed as the latest technological innovations. However, these developments do not seem to consider that we need to take a fundamentally different path in the future. Cryptocurrencies are the latest technological development to promote the notion of data as immortal - the distributed ledger is the ultimate invention of not forgetting. Not only is every transaction stored on a blockchain, but every blockchain stores every transaction. Every connected system must hold the entire list of records called blocks. Removing, decaying, or forgetting would break the system.

Cryptocurrencies are conceptualized as an accumulation of data; decay is not only excluded but would break the system. In 2021, the energy consumption associated with cryptocurrency mining alone will consume approximately 120 terawatt-hours of electricity (ccaf.io 2024). According to a comparison by the BBC, the energy consumed by crypto mining could power all the electric kettles used in the UK for 27 years (Criddle 2021). Various calculations suggest that one Bitcoin transaction emits as much CO2 as an average household for three weeks (Whitehead 2022) or about the same as a business-class flight from Berlin to London (stackexchange.com 2019). The metaverse, the dream of an integrated

network of 3D virtual worlds, is now following the crypto trend. The metaverse television series Upload is a perfect example of the dream of immortality through digital technology. The plot is simple: by 2033, people can "upload" themselves into a virtual afterlife. The metaverse is another step toward digital eternity: death lurks around every corner, and data is the 21st-century mechanism for dealing with it.

It might not be a pure coincidence that crypto, from Greek "kruptos," means hidden, as data, from Latin the given, its transformation and production are far from the metaphors describing them. The technological infrastructure puts a heavy burden on the planet. The tools to detect climate change in the first place, i.e., supercomputers and global sensing devices, are the tools that multiply the problem. Understanding and destruction amalgamate. However, the constant flux of growth and decay of the world we inhabit creates space for alternatives. The hoarding of the digital and its various trending terms only considers one side: growth, but not decay. Each new technological invention seems not only to continue on this path but to multiply it exponentially.

2.3 Conceptual Aspects

The argument I have presented so far challenges the concept of digital data as eternal. Digital data does not decay, it is or it is not. While such a concept makes sense concerning the origins of computing systems in military and research programs, it causes tremendous disruption on both social and environmental levels in the contemporary world. What if the model of eternal data is not only socially disruptive and environmentally questionable but also a conceptually flawed understanding of memory and knowledge?

In 1942, five years after the development of the first electromechanical computer (Dorsch 1989), Argentine author Jorge Luis Borges published a short story entitled "Funes el memorioso" (later published in English as "Funes, the Memorious"). It is a tale about a man, Ireneo Funes, who acquires the ability to remember everything after falling from a horse. In the short story, Funes is, for example, able to remember every shape of every cloud at every moment. However, Borges' story is not just fiction: several people with savant syndrome have abilities similar to those described by Borges. For example, Kim Peek (1951-2009) was able to name every city in the U.S.-almost 20,000 in all-including its zip code and area code, as well as the highway leading to each city. Among other things, he knew the contents of 12,000 books by heart (Weber 2009). These various abilities remind me of the digital systems in which we are embedded. An e-book reader or smartphone can easily store 12,000 books. A dataset of all U.S. cities, including various data dimensions, is less than 1 megabyte. Digital data has capabilities that hold similarities to those described above. But, as Borges writes, Funes's new ability came at a price: "He was, let us not forget, almost incapable of general, platonic ideas" (Borges 1942, 114).

The digital impulse of eternal data, of the human urge to "save for later," to record history to the fullest might replace the virtue of knowledge with masses of data. Planetary-scale networked computation

is based on the principle of storing everything, but already Friedrich Nietzsche commented on the power of forgetting:

> *Imagine the most extreme example, a human being who does not possess the power to forget, who is damned to see becoming everywhere; such a human being would no longer believe in his own being, would no longer believe in himself, would see everything flow apart in turbulent particles, and would lose himself in this stream of becoming [...]. All action requires forgetting, just as the existence of all organic things requires not only light, but darkness as well. (Nietzsche 1995)*

In "On the Utility and Liability of History for Life" (1874), Nietzsche describes too much history as a danger to life: Instead of focusing on experiencing the present, we are too busy focusing on how we are going to reflect on events once they have passed.[1] —Recording takes over living. The question of how one remembers eradicates the experience of the moment.

From a different perspective, Théodule Ribot writes in *Les maladies de la mémoir* (1881) that "the paradoxical result [is] that one condition of remembering is that we should forget. Without totally forgetting a prodigious number of states of consciousness and momentarily forgetting a large number, we could not remember at all" (James 1890). Human memory works fundamentally differently than computational data storage: In the human brain, sensory memories last only a fraction of a second. The things we devote our attention to become short-term memories lasting only a few seconds. The hippocampus plays a crucial role in abstracting the world, merging details into long-term memories of the past (Quiroga 2012). These successive layers of abstraction are missing from the conceptualization of digital data: data is not abstracted to synthesize concepts. As Borges writes: "To think is to forget a difference, to generalize, to abstract. In the overly replete world of Funes, there were nothing but details, almost contiguous details" (Borges 1942, 115) .

Forgetting and abstracting are two key components that digital storage has yet to grasp. While humans store sensory memories only for a fraction of a second, this level of gathering demonstrates the concept of how data storage works long term. Recently, I requested Google to send me a data dump of all the company's information about me. The dataset contained a vast list of my search history, spanning almost the last two decades. Google does not 'forget' it stores what I searched for on May 17, 2010, at 8:53 a.m. Data is not abstracted, forgotten, drawn together, synthesized or combined over time. Like Funes in Borges' story, data is conceptualized as a hoarding of details[2]. The natural and societal consequences of such a misconception of the differences between memory and data are vast.

In his book *Borges and Memory*, Rodrigo Quian Quiroga relates his studies in neurology to the story of Funes, as it coincided with his research findings. For Quiroga, thinking is only possible by generating meaning and concepts through abstraction and forgetting. These two factors are closely related since abstraction implies neglecting and forgetting details. Quiroga makes analogies to the technical apparatus we use to capture the world: "We do not process images in our brains as a camera does; on the contrary, we extract a meaning and leave aside a multitude of details" (Quiroga 2012, 192). Furthermore, Quiroga calls the reality of the 21st century a Funesian world in which we are con-

1. Nietzsche writes: "Before the war is even over, it has already been transformed into a hundred thousand pages of printed paper, it has already been served up as the latest delicacy to the exhausted palates of the history-hungry." Nietzsche, "On the Utility," X.

stantly bombarded with digital information, from social media and email to 24-hour news channels. The very design of how memory is conceptualized as data, as the ever-lasting, never-forgetting, lies at the core of this problem. Memory, for Quiroga, is a creative process: "To think is to forget differences, to generalize, to abstract" (Quiroga 2012, 117). Thus, remembering is not, like data, a form of endless repetition of the same but rather something in flux, an ever-changing interplay between context and meaning.

3. A New Kind of Datum

Ut nihil non iisdem verbis redderetur auditum. (Borges 1942, 111)[3]

Although digital decay is not extensively researched, it is not entirely unexplored. The topic is approached in various ways, resulting in intentional and unintentional decay. This section will present different approaches and suggest ways to conceptualize data decay further.

Lossy compression refers to a collection of methods to decrease data size utilizing imprecise approximations and discarding partial data. These formats became popular during the early days of the Internet when bandwidth was limited. Examples of well-known formats include the image format JPEG, the audio format mp3, and various MPEG video formats. The technique used for lossy compression is called *discrete cosine transform* (DCT)[4]. In JPEG images, blocks of eight-by-eight pixels are transformed into a cosine wave function, requiring less storage than the original pixel blocks. However, if a file is compressed to a high degree, the wave functions become visible within the image. It is important to note that lossy compression affects each new copy of the data, meaning that a JPEG saved repeatedly will lose information over time. However, it is essential to note that this compression method was not intended to forget, simplify, or summarize. Its purpose was to facilitate faster file transfers over the slow internet of the 1990s.

While file compression functions on the data level of digital files, various apps with data self-destruction capabilities have been released over the past years. Gmail, for example, has the ability to send emails in a confidential mode (google 2024). This allows users to set an expiration date on their emails. Similarly, the messenger app Telegram allows for self-destructing messages (telegram 2022). When Snapchat was first launched, the app became known for its disappearing photos and videos. These examples demonstrate that digital ephemerality is not unthinkable. However, the systems are all based on a binary concept of forgetting. There is, again, no level of generalization or abstraction.

Rather than following the hype around cryptocurrencies in which remembering every transaction is a crucial system component, cryptography can also be used in reverse, i.e., to forget. The project *Vanish* by the University of Washington is an example of this: the system makes data unreadable after a user-specified period; the result is self-destructing data (Roxana et al. 2011). In 2007, Viktor Mayer-Schönberger made a similar argument about self-deleting data from a legal perspective (Mayer-Schoenberger 2007). However, the examples observed thus far are all based on deletion as the only mechanism of forgetting. Research in artificial neural networks might allow novel conceptualizations of digital memory that include generalization and abstraction. These techniques are inspired by biological neural networks that constitute

2. It should be noted that the analysis presented in this paper is somewhat ambiguous. While critiquing contemporary metaphors of computation, I am utilizing the same mechanism to draw a relation between Funes, a human character, and computational storage. However, this paper does not focus on the usage of metaphors per se, but rather on a reimagination of data beyond the binary imagination of existence.

3. Here, Borges quotes from Pliny's Historia naturalis: "Nothing that has been heard can be repeated with the same words" (my translation). First published in 1942 as "Funes el memorioso," the following translation of Borges's short story is referred to in this text: Jorge Luis Borges, "Funes, the Memorious," trans. Anthony Kerrigan, in Ficciones, ed. Anthony Kerrigan (New York: Grove Press, 1962), 107–115 (quotation on 111).

animal brains, and movements toward abstraction are built into these systems (Saitta & Zucker 2013; Abel 2022). Each hidden convolutional layer of a deep learning architecture abstracts the input layer toward the output layer. That said, the current machine learning workflows are far from the new kind of data I am imagining: machine learning is based on hoarding massive amounts of data, which are so large and computationally resource-intensive that only large corporations can train these models.

The various examples show that data decay is possible but is an underdeveloped area of research. I imagine a new digital storage format in which data decays and abstracts over time. Data should self-abstract and generalize over time rather than listing everything I have ever searched for on Google. Further back in time, the list items should merge so there is no record of every search from ten years ago but instead of the general topics of interest from that year. Similar to the current conceptualizations of degrowth (Schmelzer et al. 2022) questioning the notion of development in political, economic, and social terms, we need to redesign our notion of data as a society. Within human memory, sensory memories become short-term memories in a fraction of a second, accumulating into fading long-term memories. The hippocampus plays a vital role in this transformation. For a sustainable and socially minded collective future, we will need a hippocampus for data: a clearing mechanism for database structures to abstract, compress, and forget. Rather than keeping 50 photographs of one moment, these images would turn into a memory by slowly decaying into each other. I hope that the beginning of the 21st century will go down in history as a time of data hoarding, as an excessive time of storing the unneeded, while in the near future, we will move towards a more sustainable data ecology in which data, like everything else, decays, merges, compresses, abstracts, and simplifies over time.

4. For a simple and valid explanation of the process see Computerphile, "JPEG DCT, Discrete Cosine Transform (JPEG Pt2)," *YouTube*, May 22, 2015, https://www.youtube.com/watch?v=Q2aEzeMDHMA.

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Embracing Death Processes: A Humanistic Inquiry into Art, Technology, and HCI

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This paper investigates the theme of death within the realm of human-computer interaction (HCI) from the third wave humanistic perspective. Departing from techno-solutionism, the study adopts a critical approach informed by an ecofeminist standpoint. We conducted an exploration which resulted in the cartography of 30 contemporary artworks (from 2010 to 2023) engaged with digital culture and death processes. Ultimately, the paper maps and attempts to complexify the way death is approached in the digital age, questioning techno-solutionism and highlighting the importance of art projects in acknowledging the blank spaces, errors and glitches that come with the unavoidable ending of a cycle.

Our suspicion

This investigation was propelled by an internal, personal inquiry. Amorphous, turbulent, unknown. Discomforting in its own way, almost taking a life of its own. It found its path to outward expression and manifested itself in this written form.

Beginning at the juncture where technology and screens have become pervasive in our society, where disembodied data occupies real, physical space, we pondered how it may change over time, to whom it will belong, and what it will look like. We then questioned how death intersects with technology as a phenomenon that is unseen but experienced through its echoes and consequences.

This sparked a particular interest in analysing the landscape within our sphere of knowledge, which comprises artistic practices, technology and HCI. Our aim is to enrich what has already been done in this regard, as death concerns everyone, crossing all paths. This sense of discomfort led us to explore how artistic practices might complement current Human-Computer Interaction (HCI) approaches.

To that end, we gathered, researched, and pondered. The conclusion of this paper consists of a list of questions rather than answers.

Blurring the boundaries from a situated perspective

We approach the theme of death in the context of artefacts of human-computer interaction from a humanistic perspective (J. Bardzell 2009; S. Bardzell and Bardzell 2011; J. Bardzell and Bardzell 2015). Within human-computer interaction (HCI), the third wave is markedly humanistic and stands at the core of our philosophical and cultural positioning. The third wave expands beyond humans' relationship with technology, but also towards our cultural practices. We distance our-

Keywords HCI, Contemporary Artworks, Eco-feminism, Death, Decay, Cyclical.
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selves from techno-solutionism, which we define as the linear approach to applying a "one-size-fits-all" solution to problems (Kneese 2023, 138). We believe that techno-solutionism simplifies contextual diversity, and overlooks, for example, humanistic, ecological and spiritual approaches.

Through this lens, we align with critical perspectives towards technology, such as Glitch feminism, which embraces error, malfunctions, and failures to challenge the binary (both within computers and gender) and create ruptures (Russell 2020).

We believe that to engage with the theme of death, an eco-feminist perspective is crucial. We stand with Donna Haraway's Cyborg Manifesto (Haraway 1991) as a vehicle to expand this critical approach towards technology as well as to explore the nature-culture divide, and Situated knowledge(s)[1] . We pay special attention to her idea that "we are all compost"(Haraway 2016, 101) and "humus, not homo"(Haraway 2016, 55), which embraces the inherent life-death-life cyclical processes.

Similar to the third wave of HCI and Glitch feminism, Natureculture(s) opposes binary divisions and embraces intersectionality. It recognises the blurriness within distinctions such as nature and culture, subject and object, body and mind, and human and animal, highlighting their entanglements rather than their divisions. In addition, Karen's Barad Onto theory of entanglements and Agential Realist onto-epistemology (Barad 2007), aligns with our stance, as it introduces that material and meaning are inseparable from each other. It proposes a new way to relate to matter, subjects, and discourse.

In addition, Animism as a concept allows us to complexify the distinctions between animate and inanimate. It serves as an umbrella term shared among many ancient cultures to understand the aliveness of things (and perhaps their death). It endows that material, places and objects have agency. Similar to Barad's concept of agency, which proves that materials and objects are carriers and makers of meaning. Thinking through an animistic lens serves us to expand the territory that death covers in this research, which is not only limited to the demise of human beings.

This theoretical framework prompts us to delve into artistic practices that work through a critical and speculative lens. We believe the artists showcased in this paper visualise glitches, errors, and decay processes to create space for grieving in a profoundly different manner from startup culture.

With their artworks, they scrutinise the intersections of technology, embodiment, and ecology(s), to employ a relational approach, reflecting and complexifying this matter. We situate our study within a practical and theoretical stance, seeking to invoke reflection rather than optimisation.

Honouring the complexity

We present a situated review which has provided us with context on how this theme is currently being approached in literature and contemporary artistic practices. We strive to honour the complexity of the topic, viewing it through an expansive rather than narrow focus. Each study and artwork delves into the matter uniquely, creating new questions and conclusions, and elaborating new terminologies. After this review, we concluded that there seems to be a need to create overarching con-

1. Using knowledge(s) instead of knowledge recognizes the complexity of situatedness, recognizing that there are multiple positionings, and that we are all carriers of many Knowledge(s).

cepts or expressions to relieve the semantic blurriness when approaching death.

As mentioned above, our study does not seek to provide clarity, but rather to deepen the complexity of the subject matter. In doing so, we reflect upon some key conceptualizations of death, for example, Massimi and Charise's triad of differentiated definitions towards death, mortality and dying (Massimi and Charise 2009). We further question, investigate and contemplate how the end of life might work as a gerund, rather than a static, inanimate topic. We complement such terms with Oxford's Learner Dictionary's definition of death "Death of *something*. The permanent end or destruction of something" (Oxford 2024) to elaborate an entangled, object-oriented ontological expansion to this notion.

> *The difference between life and non-life is neither thin nor rigid...we coexist with and as ghosts, specters, zombies, undead beings and other ambiguous entities, in a thick, fuzzy middle region excluded from traditional Western logic'. (Morton 2017, 55)*

Adding up to Barad's already mentioned theory, we cannot solely attribute death to living beings, but recognize it as a distributed phenomenon involving various material and discursive elements. This is reflected in the artworks provided in this exploration, as they approach death from multiple angles, moments and attach it to multiple recipients.

Although we encountered that the way in which authors address the topic is vastly rich, critical and heterogeneous, there seems to be a general consensus on how techno-solutionism and *Thanatechnology* (Özdemir et al. 2021) is ill-equipped to handle the unfathomable intricacy and '*messiness*' of the unavoidable end of a life cycle (Kneese 2023, 35).

We encountered that the first and second wave HCI disciplines often analyse the process in a practical manner due to their positivist bias. Authors such as Albers, Sadeghian, Laschke and Hassenzahl shine a light on this matter by providing a thorough literary investigation of HCI in regards to death processes (Albers et al. 2023). They concur that most of the studies focus on a Thanatosensitive approach (Massimi and Charise 2009) which mitigates the negative aspects of grief, but consequently overlooks the potential benefits of a broader, spiritual perspective towards the end of a life cycle.

> *We suggest that thanato-technologies should also cater to the spiritual needs of dying people [...] Similarly, narratives about the afterlife, roles of the dead, and death rituals could inspire new concepts and theoretical understanding. (Albers et al. 2023, 18)*

Their conclusion also prompted us to delve into artistic practices, as we believe they can enrich this solution-oriented attitude. The authors also agree that involvement, communal exchange and collaboration are crucial for navigating this complex topic.

What hides between 0s and 1s

We present authors who, instead of adopting a pragmatic, epistemological approach, provide a rather situated, testimonial, philosophical and humanistic perspective. We can observe a tendency towards semantic exploration and analysis. Authors piece together their unique elabora-

2. This meaning, whether creating installations, platforms, exhibitions and performances that involve technological development.

tion of concepts (many of those grabbing onto established scholar definitions), to question and expand the present, heterogeneous state of this notion.

The conclusions they appear to draw from this practice focus on visualising the communicative, reflexive, and creative potential hidden in errors or voids that emerge when something fails to function flawlessly. They provide a critical view on the predilection within Western epistemology for binary categorization, and suggest to embrace the inherent value that exists in this state of "in-betweenness" (Marangoni, 2021; Kneese 2023). We believe this binarism consequently affects the trouble of engaging with these cloudy, grey areas lying between 1's and 0's (Forlano 2016; Bollmer and Guinness 2018).

Tamara Kneese postulates that death in the ephemeral digital culture presents itself as a *glitch*, casting light on unforeseen errors, unemphatic digital interactions, non-commercializable user demands, industrially hidden power dynamics and unaccounted responsibilities towards the dead and their data. The author also enriches HCI scholar terminologies such as *digital remains* (Carroll and Romano 2010; Savin-Baden and Mason-Robbie 2020) to hybridise the nature of the lingering, disembodied, posthumous data:

> *I use "digital remains" along with "communicative traces" to refer to more expansive forms of social data. Although communicative traces can become digital remains, I use communicative traces to point to the slippage between living data and the data of the dead. (Kneese 2023, 21)*

Fig. 1 *Merciless Entropy* by Mariana Marangoni, 2021.

The artistic loom

Despite having observed various cases which also speculate on how techno-solutionism appears to be directly influenced by capitalism, positivism and linearity (Öhman and Floridi 2017; Kneese 2019; Özdemir et al. 2021; Agarwal 2023), we consider artistic practices to provide a fertile soil to study the topic. We believe the artists and their artworks[2] provide a much more knotty, loom-like perspective towards death processes.

Examples like Mariana Marangoni's transdisciplinary approach to the topic perhaps can serve as evidence of the relationality and intricacy in which artists comprehend this matter. The artist elaborates a thorough, ecofeminist study towards decay in websites whilst simulta-

neously providing context to the metaphor that propels her installation "Merciless Entropy" (see Table 1 [30]). She not only provides factual, numerical information towards the ecological impact of a crumbling internet, but also introduces her own terminology, *internet entropy*, as "a sprawling space that is lost in the loop of higher internet speed, hardware improvements, '*web bloat*', and planned obsolescence" (M. B. Marangoni 2021). She embodies her critical standpoint through her art piece, drawing an analogy between decay in the digital realm and architectural ruins (see Figure 1), while also comparing analogue to digital degradation (Salera-Marangoni 2021).

Rather than offering a polished, solutionist formula that races to optimise decay, the intertwined manner in which she connects the topic to other fields may serve as an example of how art seeks to deepen the complexity of the subject. The artists[3] we'll be featuring in the following sections not only explore innovative ways on how technology can be hacked into a non-solutionist nature (see Table 1), but also participate in the debate by interweaving concepts, summoning new terminologies, exhuming socio-systemic glitches and creating fluid ways to dialogue with death and cyclicity. They seem to find the creative potential in what remains broken, not trying to resolve but rather to enrich debate (J. Bardzell and Bardzell 2015, 28) whilst resonating with what cannot be avoided.

Our exploration

We conveyed an exploration of contemporary artworks (from 2010 to 2023), which deal with the selected topic. Our aim was to expand as much as we could the way in which artistic practices relate to death processes. We also selected artworks based on their engagement with digital culture, whether through the use of technological instruments or existence within digital platforms.

To select the artworks, we searched keywords such as *decay, grief and software, digital grief, mourning, glitch, death*, and *dead data* to find works that dealt with death processes and technology. We delved into curated, digital art repositories such as The Couch, Rhizome, e-flux, and Arena. Literature and scholarly publications reviewed pointed us to other artworks. A total amount of 35 projects were researched, from which we selected 30 (see Table 1), discarding the ones that didn't have an artistic background or intention such as Chatbots or apps like Replika, an AI tool used often used by the bereaved to deal with the postmortem processes.

This resulted in a varied list of artworks that approach death processes in multiple, different formats. Some of these approach the topic in a more direct manner, whilst others in a more abstract, tangential way. We also dismembered complex artworks which included different mediums as separate objects, such as *Ghost* by Asa Horvitz which comprises a performance, a website, and an AI interface. We also included keywords, which we gathered from the artist's statement of the work or external text and reviews about the work.

In the initial phase, we pre-selected 30 projects, followed by the organisation of these into a structured tabular format with certain metadata from the artists and their work (age, residency, gender, date of release, medium, documentation and keywords). We present a table of the selected works and a brief description in Table 1.

3. We must disclaim that we are generalising the term artists, as we are not able to fully corroborate if artists refer to themselves as such.

Table 1. Artworks and descriptions (reduced version without metadata).

N	Artwork	Description
1	Donate Yourself	An AR journey and website that introduces virtual, visual and sonic expressions of our organs, cells and body of data. It proposes that, after death, they can become a collective gift of information for the next generation. (Pisillides and Body>Data>Space 2021)
2	999 years, 13 sqm (the future belongs to ghosts)	A 13 square metre room installation containing a "living" wall powered by microbes. It contains a hovering spirit and references the ever forever changing nature of organic matter subjected in the capitalist context. (Evans and Amstrong 2019)
3	The Collapse of PAL	A live AV-performance first performed on national Danish television. It features the "Angel of History", who reflects upon the demised and outdated PAL television signal. (Menkman 2011)
4	Dear Mr Compression	A multimedia project that also features the "Angel of History", as it directly addresses the compression algorithm, which alters and distorts the transmission of images, videos, and data across the internet. (Menkman 2010)
5	GHOST (AI interface)	A musical performance aimed to turn the artist's individual grief into a collective experience, using personal archives and spiritual texts. The lyrics were made in collaboration with a custom-trained AI language model. (Horvitz 2023)
6	GHOST (AI interface)	An interface where the audience can converse with the trained AI language model (the same utilised for the GHOST performance). The AI creates text based on the training (which is available to download) and the user's input. (Horvitz 2023)
7	GHOST (website)	Digital version of GHOST (performance) where the audience navigates through texts, profound music and images from personal archives of the artist and documentation of the performance. (Horvitz 2023)
8	I'm sorry I made you feel that way	An interactive experience and performative self-portrait. The artist's biometric data is collected daily via a wearable smart ring device and linked with an artificial avatar which deteriorates when its human is tired or stressed. (Menegon 2023)

9	One last click and I'll be gone	A series of AR, videos and digital-self-body-portraits clones. The clones are forced to follow a monitored cursor, struggling with the limits of the virtual environment and leaving visual traces of their movements. (Menegon 2022)
10	All alone, together	A generative live simulation and a social WebVR immersive installation, where the virtual clones of the artist's 3D-scanned body are merged as a result of an algorithmic anomaly. (Menegon 2020)
11	Unfinished Farewell	A website which reenacts a public virtual tomb, documenting the pandemic victims. It provides an image and information about the deceased which vanishes when hovered with the cursor. Users can leave messages and release their grief. (Li 2020)
12	Funeral for Digital Data (performance)	A three-day-long ritual for digital data performed by the artist. By activating a material installation, the ceremony becomes a site where data can be grieved and digital devices can be mourned. (Petrozzi 2022)
13	Funeral for Digital Data (website)	A website containing the personal and collective archives of the lost data and hardware. At the bottom, it states: *When it's the last time you experienced the loss of data?* And the only clickable button: SHARE. (Petrozzi 2022)
14	Knows too much	A workshop and installation, taking a collective digital spell to reframe the human and device connection. Participants interrogate their own smartphones and print their algorithmic lives. Closing with a magic circle where digital and discarded objects relate to four elements. (Petrozzi 2021)
15	Die with Me	A chatroom application that users can only enter when their phone is about to die (only 5% battery remaining entry). (Depoorter 2018)
16	Suicide Machine	A website and bot that removes your profile from Facebook, Linkedin, MySpace and Twitter. Every piece of information and every content piece is deleted one by one in front of the user. (Gamba and moddr_ 2010)
17	Smell of Data	A new scent is attached to a scent dispenser that can be connected to your devices via Wifi, and will release a puff to alert internet users of data leaks. (Wijnsma 2019)

18	Recursive Truth	A video based on generative AI research, using deep fakes and video games mods to delve into loss, memory and truth as a medium. (Rossin 2019)
19	The Sky is the Gap	Multi-user virtual reality installation, where users can control or scrub time through their movements. (Rossin 2017)
20	Ephemeral Data	A ten-day group performance that visualised the shift in digital culture. They created a sand mandala representing Utrecht's digital infrastructure, which was wiped at the end. Nothing was documented and it will never be repeated. (Van Loon 2019)
21	Permanent Data	Installation that uses a 12km glass fibre Direct Access Cable (DAC), usually used to connect households to a digital network under the ground. The cable is printed with the Gutenberg bible mixed with contemporary YouTube comments. (Van Loon 2020)
22	0°N, 0°E	A video installation around the cyber-myth of Null Island, a geolocation of data files that are missing their coordinates. An invitation to enter a collective, technologically mediated memory of nature. (Mora 2020)
23	Matrix Vegetal	A video and installation with sculpture-totems and dry Brugmansia flowers. The artist aimed for a temporary disengagement with the digital matrix to create an alliance with the vegetal matrix instead. (Dominguez 2021)
24	Goodbye, My Sunny Child (Life is Brief)	A monologue-video-concert starring a dying Tamagotchi, reflecting on its past life and performing a duet song with a human performer. (Moreno Roldan 2021a)
25	Salvapantallas Fantasma	An audiovisual installation composed of several obsolete televisions and an analog television transmission system. (Moreno Roldan 2021b)
26	New Mystics	A digital platform for exploring collaboratively the interconnections of magic and technology. Featuring both human and non-human voices, with texts co-authored by the Language AI GPT-3. (Bucknell 2021)
27	Inanimate Species	An installation that displays 19.125 pinned images of insects and Intel 4004 microprocessors, exposing the link between the explosions of technocapitalism and the acceleration of climate change resulting in the decline of essential ecosystems. (Moll 2022)

28	Rituals on Wasted Technology	A sound installation comprising two of his sculptures, APES and SWANS. He creates a post-apocalyptic landscape in which the recycled, animal-resemblant kinetic sculptures symbiotically relate to each other. (Barotti 2023)
29	Hyperlinks or it didn't happen	A video that follows the journey of a CGI version of the demised actor Philip Seymour Hoffman, alongside other digital entities like rendered ghosts and holograms. They explore existential questions and ethical dilemmas related to personal data ownership. (Evans 2014)
30	Merciless Entropy	A monumental, sculptural digital artwork that displays the results of a web crawler script searching for broken URLs and dead-end links. (M. Marangoni 2020)

Fig. 2 FigJam general workspace screenshot.

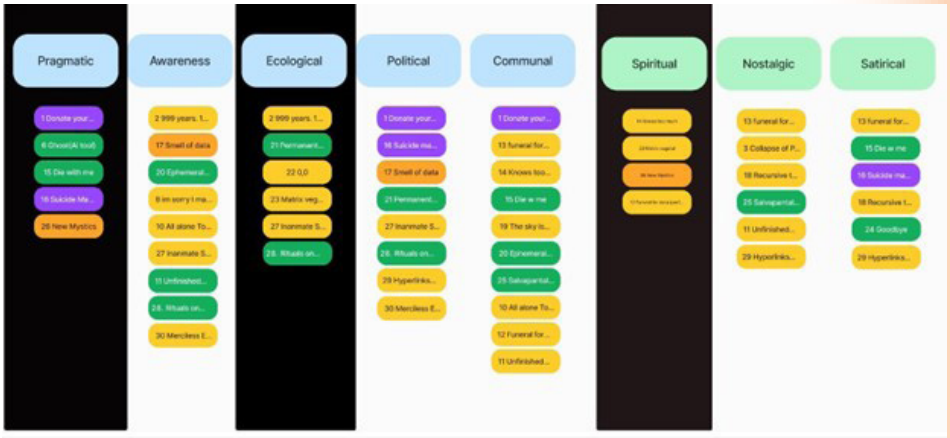

Fig. 3 FigJam sectioned workspace screenshot (artworks organized by gender).

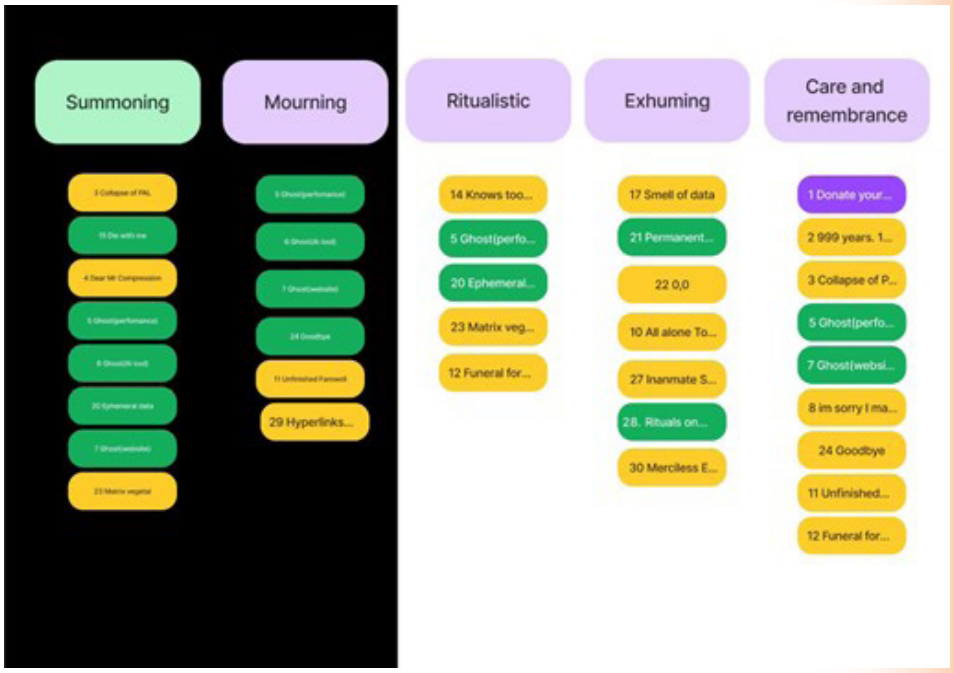

Fig. 4 FigJam sectioned workspace screenshot (artworks organized by gender).

Fig. 5 FigJam sectioned workspace screenshot (artworks organised by gender).

We then laid them out into a cartography, organising them and mapping them out through labels (see Figure 2), which helped us to understand their nuances and relationships. This process consisted of creating a free list of qualities per artwork and adding them to the table.

We gathered a total of 51 labels. Some labels came directly from keywords we found in the previous phase, whilst others from our own associative perception relating to other works. The use of a visual tool such as FigJam (see Figures 2, 3, 4 and 5) allowed us to rapidly and intuitively interact with the gathered data. These labels were then compared, discerned and grouped throughout two iterations which resulted in 18 final groups we refer to as *clusters*, defined in Table 2.

We then mapped the artworks to as many clusters as we pertinently considered. While doing this process, we refined nomenclatures and re-structured our labelling system by moving some labels from one

group to another. This resulted in a final group of defined clusters and associated artworks. We encountered ourselves making several iterations regarding the distribution, to map the amount of artworks per cluster and metadata.

Cluster	Description
Pragmatic	Has a purpose and its main focus resides in resolving that practical problem, seeking specific quantitative solutions.
Awareness	Raises a particular topic in the audience. It searches to shine a light on a specific subject to raise engagement.
Ecological	Concerned with nature processes and climate justice, with organic materials the relationship between human and more than human.
Political	It engages in deliberate communication aimed at critiquing and interrogating a specific issue, emphasising the responsibility to take action toward its resolution.
Communal	Aimed to gather collective testimonials and cultivate an immersive communal experience. It prioritises the group processes over individual concerns, fostering a sense of shared involvement.
Spiritual	Concerned with mysticism and esotericism. Mediates between the physical and the metaphysical realms, as well as engaging with animism and the afterlife of objects or materials.
Nostalgic	Evokes a feeling of nostalgia, Awareness remembering the past with an emotional and melancholic tone.
Satirical	Introduces humorous critiques, implementing blunt, sarcastic language, dark humour and metaphors.
Summoning	Focused on evoking specific emotions to an audience, luring them into the work in a sort of poetic enchantment.
Mourning	Involves the grief processes of emotional, psychological, and sometimes physical adjustment to the reality of a loss.
Ritualistic	Engages in a ceremonial series of actions, often with spiritual undertone and communal gatherings. It might use specific objects, implemented with intention and care for rituals.
Exhuming	Digs up and illuminates what was previously unseen, forgotten, or buried—both in physical and metaphysical realms. Exhumation reveals glitches, errors, failures, anomalies, and the specter of death.
Care and Re-membrance	The act of memorialising. “Re-membering” recognizes the inseparable entanglement of different elements within a larger system.

Phygital	The hybridity concerning the physical body and digital self. It refers to the digital embodiment that involves both flesh and bones, as well as pixels and data.
Spectral	Relates to the intangible, immaterial, eerie and ghostly. It can be associated either with objects, living beings or afterlife entities.
Decay	Refers to the gradual deterioration or decline of something over time, often resulting in the loss of quality, functionality, or vitality.
Obsolescence	The state of being outdated, forgotten, or rendered obsolete due to advancements or changes in the present context. It is related to the ending of a life span, the decline or discontinuance of certain practices, ideas and objects.
Sensorial Incarnation	The act of something immaterial, digital or metaphysical incarnates into a material form. The viewer experiences the transition from the imperceptible to the perceptible.

Next, we analysed all the work done in FigJam and decided to discard some of the contrasted metadata (the artist's nationality, age, the artwork's medium, date, etc.), to focus on the data that we perceive to be more relevant. We decided upon selecting the gender metadata to draw our conclusions for this paper.

From a quantitative analysis, we note that there is a bigger percentage of women overall (Table 3). The clusters with a larger number of men are *Summoning* and *Mourning*, and the one with most women is *Spectral*, followed up by *Decay, Care and Remembrance* and *Communal.* The clusters that are the most populated and heterogenous are *Communal, Awareness and Political.*

What we can draw from this exploration is that there is a broader spectrum of labels which relate to a more metaphysical aspect of death. We encountered more nuanced terms, such as *empty, void, ceremonial, ghostly*, and *mysticism*. Clusters such as *Spiritual, Ritualistic, Exhuming, Spectral, Decay, Summoning and Sensorial Incarnation* may serve as evidence of how art can cater to the need to engage with the topic in a broader way, a practice that may be lacking in HCI (Albers et al. 2023).

Cluster	Artworks by Women	T	Artworks by Non-binary	T	Artworks by Men	T	Artworks by collectives	T
Pragmatic		**0**	[26]	**1**	[06][15]	**2**	[01][16]	**2**
Awareness	[02][08][10][27][30]	**5**	[17]	**1**	[11][20][28]	**3**		**0**
Ecological	[02][22][23][27]	**4**		**0**	[21][28]	**2**		**0**
Political	[17][27][29][30]	**4**		**0**	[21][28]	**2**	[01][16]	**2**
Communal	[10][11][12][13][14][19]	**6**		**0**	[15][20][25]	**3**	[01]	**1**
Spiritual	[12][14][23]	**4**	[17]	**1**		**0**		**0**
Nostalgic	[03][11][13][18][29]	**5**		**0**	[25]	**0**		**0**
Satirical	[13][18][29]	**3**		**0**	[15][24]	**2**	[16]	**1**
Summoning	[03][04][23]	**3**		**0**	[05][06][07][15][20]	**5**		**0**
Mourning	[11][29]	**2**		**0**	[05][06][07][24]	**4**		**0**
Ritualistic	[12][14][23]	**3**		**0**	[05][20]	**2**		**0**
Exhuming	[10][17][22][27][30]	**5**		**0**	[21][28]	**2**		**0**
Care and Re-membrance	[2][3][8][11]12][24]	**6**		**0**	[5][7]	**2**	[1]	**1**
Phygital	[8][9][10]	**3**		**0**		**0**		**0**
Spectral	[3][4][9][11][18][19][22] [29]	**8**		**0**	[5][7]	**2**		**0**
Decay	[2][3][4][8][10][30]	**6**		**0**		**0**		**0**
Sensorial In-carnation	[8][12][14][17][30]	**5**		**0**	[20][21]	**2**		**0**
Obsolescence	[12][13][14][29][30]	**5**		**0**	[24][25][28]	**3**		**0**

Acknowledging the blank spaces

To add to Kneese's glitch analogy, our exploration leads us to conclude that death paradoxically presents itself as an exhuming force. The blank spaces it leaves as it expands over every aspect of our existence ignites a particular type of paranoia, a fervour to resolve all. It evidences an intrinsic human necessity to fill every vacant space with a plethora of meanings and formulas that offer a momentary solace.

Nevertheless, we find there is a distinction between art and technology in their attempt to fill in these blank spaces. The way in which technology and art approach the topic is very different. The binomial dogma that often underlies technology doesn't consider buried, glitchy or grey areas. Perhaps, this is the time when what lays underground, silent, between the creeks of 1 and 0's emerges to haunt us all.

As opposed to trying to solve the topic of death, art mimics its exhuming nature. It is within these empty creases that artists find ways to question, complexify, embrace and challenge such matters. Some artistic practices provide agents who encounter death in its multifaceted and ever-changing nature a way to portal to this particular type of unknown.

In fact, art which encompasses technology as a tool to critique or help this matter is almost accidentally integrating it to the issue. It repurposes technology's obsession to provide practical answers and

metamorphosizes its perfectionist DNA into a much more empathetic, admittedly flawed, communal and powerful vehicle.

The works of the artists featured in this paper adopt a voice of their own, with which spectators, users and mourners interact with. The questions they come up with aren't made to be completely answered by techno-solutionism. Instead, art practices that use technology and make HCI proposals, critique the established forms of ritualizing, caring, coping and memorialising the dying, deceased and their potential afterlife, while proposing new approaches and methods. These converse with this void, without trying to fill it. They deliberately create glitches, errors and failures that aren't looking to be solved.

As death refuses to have any time or structure, approaching the topic requires a sort of humility, a surrender to what we cannot control. In the same way artistic practices mimic the exhuming force of death, the way in which some artists[4] address this topic can be also related to a more honest, porous attempt to approach cyclicity (which inherently comprises the ending of one).

An interesting observation is to note that, throughout this exploration, we've encountered a higher representation of female theorists and practitioners' voices who focus on this topic.

This can be observed not only in the presented literature, but also in the woman artists present in this paper.

Clusters such as *Spectral, Spiritual, Decay*, and *Phygital*, which deal with the intangible, cyclic and blurry nature of death processes, have a larger percentage of women artists.

The *Spectral* cluster approaches death in its immaterial, auratical and ghostly qualities (Table 1, e.g. [2, 3, 11]). In some way, it already acknowledges that the topic itself is something too separated from our human capacity to grasp. There is an ethereal nature associated with this group of labels. Peace is made with what cannot be seen, yet exists. In addition to that, the non-traditional or religious forms in which this techno-auratic realm is approached in the artworks that are part of the *Spiritual* cluster (Table 1, e.g. [23, 26]), as well as the cyborg-integration of our digital and biological selves in the *Phygital* cluster, show us that perhaps women are the ones more concerned in creating new strategies, dynamics and spaces to approach this topic. These go about conversing with what lies between binaries. They honour the agency of our unfleshed, digital avatar, as seen in (Table 1, e.g. [8, 9, 29]), as well as mingling with mourning techniques that involve invisible data.

The end of a cycle is directly related to the Decay cluster. The fact that many of these artworks are propelled by women denotes an acceptance towards the way in which death slowly advances towards every process. To add up to the humbleness mentioned before, this cluster implies the posthuman notion and acceptance towards considering ourselves beautifully flawed, dying specimens. They commemorate erosion, creating artistic representations that do not seek immortality or reparations (Table 1, e.g. [4, 10]), in an attempt to approach "finitude as a blessing and not a curse" (Kneese 2023, 25). We ponder: Does a correlation exist between the cyclical biological nature inherent to women and their innate capacity to engage in contemplation of life's intricacies through a non-linear, interwoven lens?

The decline implied in the *Obsolescence* cluster, which addresses topics very closely tied to the discontinuing (and consequently death sentencing) (Table 1, e.g. [24, 25, 30]) has no particular gender majori-

4. We are referring to all artists that identify as women mentioned in this paper. We recognise that womanhood doesn't only belong to cis--women and that it expands beyond biological sex.

ty. This shows that there is a general approach to deterioration, but the manner in which it is approached isn't gender-innocent.

We find compelling the ways in which feminist perspectives[5] can enrich the existing techno-solutionist practices. Nobody has a recipe as to how to transit the uncertainty of death but, from our point of view, feminist approaches and methods seem to stand comfortably in this dense fog, creating tools to walk blindly.

Breaking the line

There is an evident linearity driven by startup culture (Kneese 2023) that aims to optimise grief and hack death with the promise of immortality. We believe death breaks this line. It evidences its failures.

What we can draw from our exploration is that this clearly manifests in the lack of digitally adapted mourning rituals, the masked, commercially driven promises to preserve digital legacies, the lack of empathetic tools towards the decay and demise of beings, objects and their bereaved, and the fetishization of immortality for our digital selves. Maybe the topic shouldn't be solved, nor optimised, as death cannot be escaped, altered, hacked, mapped or linguistically grasped.

In artistic practices, we've encountered works which incarnate or express emotions, awareness or political perspectives (Table 1, e.g. [17, 21, 28]) towards death via their artworks. These artworks problematize a linear approach to the phenomenon. Perhaps, as technology has advanced, we have overlooked cultural legacies as significant as ancestral knowledge rituals, which encode methods for managing cyclical ecological harmony with the environment. How to integrate everything that is approaching death into our discourse as a fundamental part of the cycle? How can we reconcile with decaying processes, deterioration and unavoidable endings?

Knowledge(s) from other cultures which perceive objects from an animistic lens, enrich these processes, (Table 1, e.g. [22, 23, 26]). Looking at objects as animated beings becomes a useful strategy to incorporate nuances into the way we perceive death. The animistic approach when commemorating the lifetime of hardware, ritualising the death of discarded devices (Table 1, e.g [24]) and mourning data that has been lost (Table 1, e.g [12, 13]), recognises that technology might also revolve in cycles, a perpetual rhythm of creation and decay. How is HCI broadening its approaches and methodologies to better relate, reflect and consider planetary, ancestral knowledge(s)?

Fostering collective engagement

There is hopefulness in the variety of genders and the multidisciplinary artworks that fall into the clusters of *Communal, Awareness* and *Political*, which are woven with each other. We value visions that portray the democratising nature of death (Table 1, e.g. [1, 10, 15]). Death is inherently a social activity (Kneese 2023, 21) as we are made human through addition, not subtraction (Jackson and Kang 2014).

We perceive that these processes are enriched by togetherness. Dialoguing with the blurry "messiness" of death processes requires communal care and exchange, not in a frenetic quest to solve it, but to simply be able to transit it. Some of the artworks present in the table require a

5. Deepening the debate around gender within technology falls outside of the scope of this paper. However, it does cross our research and might be considered relevant and enriching as a hypothesis on how gender is related to ways to address this topic.

clear collective gathering to take place or channel expression and emotion (Table 1, e.g. [5, 11, 14]).

In the same way that mourning practices require collective gathering, art practices cannot be separated from their social nature. Certain artworks gather people to surrender to the cyclicity of compost (Haraway 2016). Decomposing evidences that dying is an unwoven, knotted collective experience. A memorial isn't about the demised things or beings only, it is about creating a spectral, ritualistic loom that holds the space for the tensions of unanswered questions.

With this research we are not attempting to arrive at concise solutions and answers, but rather to complexify, to continue to trouble the topic and our perspective towards it. We question ourselves: Are the empty spaces death leaves necessary to birth new processes? Should we cease the quest for solutions, and surrender to the tacit? What remains unresolved also occupies a space in this life. It should be respected and honoured. Are we neglecting the sacred potential of the end, the empty, the blank? Are we scared of embracing the intrinsic fertile nature of death, in a misunderstanding of life as a complex cyclic phenomenon?

Further research

As an initial approach to the topic of death, we recognize that it encompasses a broad range of interpretations, making it difficult to grasp all at once. Our primary objective is to explore what has been said, done, and expressed by mostly contemporary theorists and artists on this subject.

Although our goal is to explore various perspectives rather than narrow our focus, there are some specific areas that stand out, such as the idea of the "death of data" or hardware, as well as the emergence of new terminologies related to death and technology. These concepts are intriguing because they reflect unforeseen scenarios that traditional language struggles to describe.

We also find it crucial to expand our artwork repertoire, as we've noticed that a big number of them are related to the climate crisis and troubling futures. We also find that conveying an analysis between lesser artworks might also be fruitful to further go into detail into the context in which they were produced (possibly engaging with the artists themselves).

Since most of the selected artworks are by European artists, we plan to broaden our scope to include works from other regions, such as the Global South. By doing so, we can explore diverse cultural, religious, and ancestral knowledge(s) on death, along with various rituals and their connections to technology.

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Where are the media artist mothers (and other parents)? Embracing Intersectional Feminist Perspectives in Media Art

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Assuming the rare presence of mothering/parenting related subjects in the media art field, this paper introduces key elements to start a fruitful discussion on the complexity around the topic and possible improvements in this specific art environment. By means of intertwining an analysis of selected media artworks related to mother/parenthood with partial results of an ongoing online survey, the discussion sheds light into how the artistic expressions relate to contemporary feminist perspectives, even if their starting points and creative processes are not directly referring to feminist theoretical frameworks. In order to address the historically constructed gender gap in the technology environment which is also mirrored in the media art field, the paper proposes visibility as the first step to promote the significant, required and urgent changes, followed by initiatives on technological aesthetic education for under-represented groups, including mothers, and more collective approaches to the problem.

1. Introduction

To a certain extent, it is possible to deduce that the rare presence of motherhood as a topic in media artworks mirrors the gender gap observed in the technology environment until today. Even in more privileged societies of the Global North, the still existing occupational stereotypes point to gender and race segregation in both the tech and the creative industries, prevailing traditional patriarchal spatial divisions and gendered labour (Negrey and Rauch 2009; NACGW 2021). Understanding technology as the "result from a series of specific decisions made by particular groups of people in particular places at particular times for their own purposes" (Wajcmann 1991, 22), the feminist literature relating gender dimension with scientific and a technological production is relatively recent.

According to Rosi Braidotti (2022), feminist technoscience studies emerged in the 1970s primarily within the medical and biology fields. The focus was on bodies, reproductive health, and sexualities, beginning with reference to women's and LGBTQ+ people's bodies and progressing towards non-human ones. The movement included a reaction against obstetric and other types of violence against female and gender non-conforming bodies. The inquiries included how biomedical sciences produce 'normal' bodies based on deterministic anatomical, physiological, genetic, hormonal, neurological, behavioural, and other characteristics.

Later in the late 1980´s with the new paradigms of communication and expressions enabled by the electronic and digital media cultures, it pops up a variety of experiments with feminist technobodies, boosted

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in the 1990´s with the popularization of the internet and discussions on cyberspace (Gibson 1984), cyborg (Haraway 1985) and cyberfeminism (1997). As iconic examples of this movement we can mention the Australian art collective VNS Matrix, who published *The Cyberfeminist Manifesto for the 21st Century* (1991) (Munder 2019), and the First Cyberfeminist International held in Kassel, Germany. The later circumscribed cyberfeminism as a "fresh ideology" that "creates a space for women to invent, dissect and alter the trajectories of the new technological and information era" (First Cyberfeminist International 1997). Problematized since the beginning of its history, the term cyberfeminism is plural, however grounded in "the idea of creating a new comprehensive label for an interdisciplinary gender-related discourse on the net" (Sollfrank undated).

Since then, the exponentially expanded potential of digital media for network initiatives triggered a plurality of technofeminist expressions. Nevertheless, in this context, the technofeminist discussions around motherhood/mothering[1] is often affected by both phenomena: either to consider motherhood/mothering as a burden and barrier for emancipation and therefore not relevant – following some feminist voices (Liss 2009; Vivas 2021), or to overlook the ethnic and class aspects of it (hooks 1978; Vivas 2021). In this regard, the ongoing research also investigates counterexamples of these phenomena, making efforts to approach the intersectionality of the selected and analysed media artworks and artists. This is not an easy task, once as we shall see, the dominance of examples stems from quite privileged contexts concerning the access to scientific thinking and to technological tools – which can be questioned as domineering knowledge production paradigm, however it represents a crucial weapon for survival and self-defence in the technocratic environment most of us are living.

In addition, when it comes to the variety of profiles of female media artists, it is often the case that they delegate the technical development of their artwork to male colleagues and partners, and technofeminism is not necessarily an issue for their creative challenges. Despite the significant changes of the last decades, there are still a series of facts and taboos that artist mothers face when they decide to have a child/children and option for the challenges of finding a balance between child care work and the professional occupation (Liss 2008; Judah 2022). These challenges may manifest in various ways, spanning both practical and psychological dimensions. For instance, the typical timing of exhibition openings (which frequently coincides with the time when children require need to be fed, bathed and put to bed) can be a source of difficulty. Additionally, the inflexibility of residency programmes can pose challenges for those seeking to combine parenting with their artistic pursuits. Furthermore, the perception that a career in art is untenable for those who choose to have children is a prevalent concern, reinforced also by art school professors. In order to bring about awareness among the agents of the art system of the discriminatory modus operandi of their institutions, art critic Hettie Judah and a group of artist mothers wrote and published online *How not to exclude Artist Parents - Some Guidelines for Institutions and Residencies* (Judah et al. 2021).

In this context, the maternal ambivalences (Rich 1978; Parker 2005; Vivas 2021) – the coexisting feelings of love and hate in maternal subjectivity – combined with the demands of the art field within precarious working conditions, clearly reveal the unjust structure denounced by

1. We understand the distinction between the terms ´motherhood´ and ´mothering´ according to the reflections by Adrienne Rich, referring the first to the (patriarchal) institution and the later to the subjective experiences of those self-identified as mother (Rich 1978).

the scholar and feminist activist Silvia Federici (2017) in her body of work, especially her critical perspective on Marxist theory in relation to reproductive labour.

Given such scenario, it is impressive that the profound impact that getting pregnant and becoming a parent mean, a radical reinvention of being in the world in corporeal and social terms, is such an overlooked topic in the media art system, particularly considering the most transgressive and radical expressions within the field. Being a care giver demands continuous adaptations in so rapid and eventually even faster rhythm as technological environments require.

Just by introducing these few points it becomes clear how complex is the entanglement of subjects. To dig into the multiple facets of the problem, the ongoing postdoctoral research to which this paper belongs investigates representations and experiences related to motherhood/mothering within media art, by collecting and analysing media artworks from a specific profile of mothers/parents: artists that are also technologists, creating their proposals in the intersections between scientific and technological knowledge, whose artworks or performances reveal sorts of media thinking, investigative and/or critical approaches to technocultures and/or technofeminist perspectives.

Observing artworks, the context and the motivations of the media artists to produce influenced by and addressing the experience of parenthood, the research aims to give more visibility to these actors in their symbolic and social struggles. In this sense, it is part of the global effort to enrich the art and technology environment with higher variability of imaginaries, with the specific challenge to highlight how contemporary media art production is shaping post-human motherhoods/mothering experiences.

As a tiny fragment of the aforementioned research, this paper is structured in three parts. Primarily it introduces the ongoing online survey *Where are the media artist mothers (and other parents)?*[2]. In the sequence, it presents a few media artworks carefully selected to feed the discussion around the mother-related operationalities, the maternal ambivalence and mother-offspring relationships, as well as to the appropriation of the mother concept beyond humanness. The paper concludes addressing the possibility of handling an intersectional feminist approach in relation to the discussed media artworks and pointing possible further developments to enhance the presence and conceptual freedom of media artist mothers in the production system.

2. Towards visibility and networking

2.1 Online survey: Where are the media artist mothers (and other parents)?

As part of the research activities, since 2022, I collect information about media artists and their artworks that emerged from their experience while becoming a parent through the online survey *Where are the media artist mothers (and other parents)?* The questions were formulated around the profile of the parent, their perception of their relation to technological tools and how this influenced their process of becoming a parent,

2. Available since 2022 at the link https://docs.google.com/forms/d/1PE0wVa2QVCKICNSzA4xTVsCDlIoL7i54gsMVOj8Y8b0/edit Accessed Feb 6 2024.

as well as how this experience influence their artistic production and career.

The online survey has been disseminated in conferences, newsletters of institutions and initiatives related to media art and motherhood (e.g. ARS ELECTRONICA Center and *Mehr Mütter für die Kunst*) and through direct requests by the author per email and conversations.

Until May, 3rd only 33 artists have contributed to the survey and the profiles are diverse concerning geographical (mostly from Europe and USA) and cultural backgrounds. Despite the plurality of responders, the reduced variety of identities from four continents clearly evinces the lack of representatives of the Global South: 9% from Latin America and no representative from African countries.

The richness of the references provided by the participants were essential to amplify our perspective in the sense of observing how differently people are affected by the experience of becoming a parent, reflecting, on the on hand, the intersectionality of the profiles, and on the other hand, a common concern related to still to-be-developed structures that better accommodates media artist mothers while balancing their activities as caregivers and artists.

2.2 Possible further development

The partial analysis of the collected data demonstrates the need to find strategies to disseminate the survey in other continents still under represented among the participants. Comparing the proportion between the huge amount of female representatives of the Ars Eletronica's archive *Women in media arts*, it is known that much less women are media artists in the Global South, however, we are aware that they exist and are potentially the target audience of this ongoing research.

Based on the survey, it would be welcome to organize an online platform to publish the results of this initial mapping, open to be continuously updated. The platform could also function as a hub of support for media artists' parents, sharing themes, discussions and tools to be constructed collaboratively by the community. Exhibitions and publications could emerge from the self-organized articulations of the participants, moderated by the more active members. To achieve this ambitious (or perhaps utopic) goal, it would be important to contact other already existing organizations of artist mothers and related profiles, and to apply for additional exclusive funding.

3. Motherhood/mothering related media artworks

In this session I present selected media artworks relating and problematizing motherhood, including pieces mentioned by those who answered the survey. They are samples to foster the discussion in three main axes: one that considers mother/mothering throughout the abstraction of their operationalities (e.g. fertilization, pregnancy, birth giving, care work, among others), a second one that approaches the mother-offspring relationships, and a third axis that addresses the transposition of the concept of motherhood to non-human contexts.

3.1 Mother/parenthood operationalities: fertility and pregnancy

I start with the intriguing *In Posse* (since 2019)[3], by British artist Charlotte Jarvis in collaboration with professor Susana Chuva de Sousa Lopes, Kapelica Gallery / Kersnikova Institute and MU Hybrid Art House Eindhoven. The art project sharply reviews historical hierarchies established on the human reproduction by means of creating viable semen genetically modified from her own cells. According to Jarvis, the project comprised three parts: (1) to grow spermatozoa (sperm cells), (2) develop a female form of seminal plasma (the fluid part of semen) using material donated by multiple women, transgender and non-binary people, and finally, (3) the "female" semen was used in a series of re-enactments of Thesmophoria, the ancient Greek women-only festival.

Fig.1. Female semen half way through being made and fresh out the fridge. Photo credit: Miha Godec. Source: Jarvis´ website.

The project cleverly addresses the core of human fertility and blurs the border between gender and sex, commonly challenged in theoretical frameworks of gender studies (Butler 1999) but hardly dissolved when it comes to the very concrete material and cultural constraints one is subjected to in everyday life. In an ideal art and science collaboration, the steps of the project stimulated new relevant scientific questions towards new findings related to human fertility. In the video-documentation of the project Jarvis states: "At every point our experiment stops working one of the mechanisms by which sperm is made is revealed, and equally one of the ways in which people can be infertile is discovered.") (Jarvis 2021: 10'40"-10'50").

Another intriguing art project relating technological solutions for human reproduction issues is the ongoing *Surrogate works* (since 2022), by Chinese-US American artist Lauren Lee McCarthy. It consists of a series of intriguing and provoking initiatives encompassing a series of films, sculptures, installations, publications, and a live performance. The starting point is that the artist becomes a surrogate mother, offering not only her own body to host the offspring of an infertile person or a homosexual couple who wish to become parents, but also the possibility for them to control each of her actions during the pregnancy through an application.

Creating a multitude of storytelling fragments McCarthy invite us to reflect on old and unsolved issues such as surveillance and social control through technological means, on the energetic, symbolic and affective costs of reproduction work, on how surrogacy has been an option

3. The term "in posse" derives from Medieval Latin, meaning "not in actuality, having a potential to exist". In collaboration with FutureFest, Charlotte Jarvis made a film version of the project available at https://www.youtube.com/watch?v=Sg_NKJaets0 Accessed Feb 8 2024.

for women in poor countries with precarious works conditions (Lewis 2019) and what does it mean to risk your own body in an apparently altruist act. The virtue of McCarthy´s proposal lies not only in challenging the historical tradition that reproductive technology is delivered into men´s hands (Wajcman 1991), but it inquires the complexity of reproduction work since the beginning on the preparation of getting pregnant, including the possibility of a self-subjected non-trivial condition.

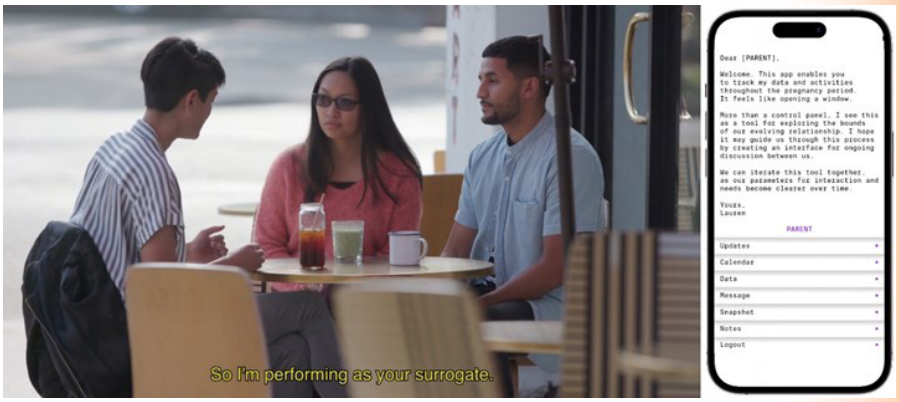

Fig.2. Left: Extract from the video *Surrogate*: Conversation with intended parents. Right: Frame of the app. Source: McCarthy´s website.

In a more sci-fi like direction, Spanish artist María Castellanos has been working on *Cyborg Genesis* since 2019, a series that envisions the future of human reproduction. The series includes a video artwork and a wearable machine capable of monitoring a posthuman uterus. Castellanos drew inspiration from Shulamith Firestone's *The dialect of sex* (1970), which encouraged women to take "control of human fertility, distinguishing between sex and reproduction" (Castellanos 2019). Speculatively, this project explores the potential for the development of an external and portable uterus which, in conjunction with other scientific and medical advances, could enable human reproduction beyond biological limits.

Fig. 3. Speculative design of a wearable machine capable of monitoring a posthuman uterus, by María Castellanos. Source: Castellanos´ website.

Through their particular perspectives, the three aforementioned artworks problematize the complexity of two main operationalities

commonly related to the concept of a mother: getting pregnant and gestating.

Xenofeminist ideas about the potential to 'change nature' (Laboria Cuboniks 2015) are prevalent in the proposals of Jarvis and Castellanos. The former appears to be closer to achieving the artist's desired function of art as a cultural artifact and process capable of transforming unequal biological and social contexts. McCarthy, in turn, who examines social relationships in the context of surveillance, automation, and algorithmic living, propose subverting control tools to review the relationship between surrogates and future parents. The common thread is a critical material examination of the modus operandi structuring human reproduction, both at the level of the body and in the geopolitical sphere.

3.2 Maternal ambivalence and mother-offspring relationship

Amidst the despair of how life would be after becoming a mother, Brazilian artist and technologist Lina Lopes developed *Cybaby* (2014), a performance based on the use of a neural helmet for newborns and a data visualization, exhibited in the context of *Hibrida: experimental prototyping of perception amplifiers* in São Paulo, curated by Paloma Oliveira. According to the artist´s own words "I was afraid of the next step in my life, being a mom, and tried to bring this to my comfort zone: a project in art and technology", with the support of GIIG (Grupo Internacional e Interinstitucional de Pesquisa em Convergências entre Arte, Ciência e Tecnologia), an academic group at the University of the Estate of São Paulo (Unesp).

Fig. 4. Performance of *CyBaby*, by Lina Lopes and her daughter Diana Muggler Lopes Moreira, 2014. Photo credit: Fernanda Duarte. Source: Instagram profile of the artist @lilo.think. Accessed Feb 13 2024.

CyBaby was a project designed to monitor the electroencephalographic patterns (EEG) of newborns, which constitute a unique brain signature. The aim of *CyBaby* was to examine and record the first stimuli experienced by newborns, such as suckling, recognizing the faces and sounds of their parents' voices, and feeling different textures. It was a poetic experiment that aimed to transform data collection and recording into tangible material through a digital performance. The project proposed a rudimentary transcoding of the thoughts of a newcomer to the world before she learns the language(s) of communication, and problematically, before she could consent to the use of her own biodata. Would the use of children's biodata be handled differently in the artistic context than in the medical and entertainment contexts? A number of ethical issues are raised by this question, similarly to any case that involve children's participation in the mother's artworks.

Continuously motivated by “the dialogue with someone with fresh thoughts about the world” (2023), a few years later, when her daughter already could speak, Lina Lopes also developed *Scribe bot* (2020)[4], a project that evolved from the conversation between the artist and her daughter “ -Mom, you’re not an artist, you don’t know how to draw!”/ “-But I can make a machine to draw for me...” (Lopes 2023)

Both artworks developed by Lopes insert the subject motherhood in the field of media art from a relational perspective, revealing the imaginary of a media artist mother shaped by the binomial relationship mother-offspring. Without appealing to political layers of the issues, Lopes uses her creative freedom in a situation where she has already secured her place as an artist and technologist.

Another approach to the mother-offspring relationship can be through the very materiality of the chemical exchanges through the placenta, the intermediate ephemerons organ. This is one of the entrances to the topic by the author through the conceptual artwork *Placenta: Interface* (2022) and *Abstracted placenta* (2023), praising the fascinating multiples roles that the organ plays along pregnancy, inclusive its welcoming analgesic properties for after birth. In addition, in *Cyborg placenta* (2023)[5], by María Castellanos, the artist explores the possibility of preserving a placenta outside the womb while keeping it alive.

3.3 Beyond humanness

By means of abstracting the mother-related operationalities, it is interesting to observe the transposition of the concept to non-human contexts. Here we highlight two examples of “machinic motherhood”: The first is *Génesis: dinámicas de organismos artificiales* (2016), by Ana Laura Cantera, in collaboration with Leonardo Maddio y Daniel Alvarez Olmedo. In this piece, the artists symbolically recreate a gestation and birth of artificial organisms, in an equally artificial context of water, movement and light. The installation plays a critical role in the life cycle of robotic organisms, undergoing an evolutionary and non-cyclical process within spherical acrylic containers, exhibiting embryonic movements. The containers have biodegradable plastic openings that are gradually corroded by the organisms’ constant movement, leading to the organisms’ eventual emergence or ‘birth.’ The installation provides an immersive experience for visitors as they observe the dynamic interactions between the robotic entities and their environment.

Fig.5. *Génesis: Dinámicas de organismos artificiales.* 2016/2018 Source: Olmedo´s website[6].

4. Video documentation available at https://vimeo.com/758939686 Accessed Feb 13 2024.

5. This piece is part of her previously mentioned series *The Cyborg Genesis*. Further information available at https://www.mariacastellanos.net/?/=/seccion/projects/entrada/cyborg_placenta_eng Accessed Feb 13 2024.

6. https://alvarezolmedo.wordpress.com/2021/04/26/genesis-dinamicas-de-organismos-artificiales-instalacion-robotica-interactiva-y-evolutiva-2016-2018/ Accessed Jan 30 2024.

According to the documentation of the work at one of the artist´s website, the installation draws inspiration from the symbolism of water as a source of life and regeneration, reminiscent of ancient mythologies that associate it with the amniotic fluid of the womb. The installation explores the fusion, tensions and mutual influences between nature and artificiality, envisioning the gestation of robotic organisms capable of engaging with the contemporary world marked by crisis and technological advancements. It reshapes the historically constructed narrative that set the natural and the constructed entities in dichotomous relationships, guided by the principles of science and art, stimulating social reflection around the poetic possibilities inherent to animated matter and the genesis of hybrid beings. According to the artists, the project aims to create a transformative interaction between the human body and robotic organisms, symbolizing a new cosmological narrative for our complex and rapidly changing world.

A second intriguing transposition of the concept of motherhood to electronic artefacts, suggesting a symbiotic relation between machinic and living organisms, is the installation *MotherPlant* (2015-2021), by Jenny Pickett and Julien Ottav (Art collective APO-33). The piece consists of a computational mycelium recycling network using dead motherboards from old computers. The artists turned them into a micro-farm land aiming to recycle the electronic components and to produce electrical current, envisioning to create an alternative open system for computational data exchange. According to the artists, *MotherPlant* proposed on the one hand the *"re-creation of the fungal network as an electronic mutation"*, and on the other hand, the creation of "*a new form of electronic circuit that mutates with a primitive fungal network*."[7]

Fig. 6. Installation *MotherPlant*. Source: Pickett, undated.

They add that *MotherPlant* emerged from a previous project on recycling electronic waste using plants, flowers, and mushrooms, and its conceptualization relies on the motherboard being one of the symbols of cyclical consumption and the artist´s obsessions with digital speed. The idea was to produce electricity to power electronic circuits, so that they in turn could power a sound installation indefinitely. The artists explain that the dynamic process begins with a few spores settling down on a nutritious surface. When these spores wake up in close proximity to one another they start germinating at approximately the same time and grow outwards as thread-like cells (hyphae) at a similar rate. The electronics feed on both the sun and wet soil, pregnant with (DIY) myce-

7. Further information available at https://jennypickett.art/doku.php?id=motherplant Accessed Jan 30 2024.

lium growth. As an information superhighway the interactions between a large, diverse population of individuals speeds up. It allows individuals who may be separated to communicate and help each other out. It also allows them to commit new forms of communication.

From this experiment began a combination of ideas about art, ecology, recycling and alternative energies sources. A whole range of subjects combined in a single cycle of sculpture or repetition of sculptural forms. The artists reflected on the coincidences of terms in organic and machinic environments, e.g., that the shape and layout of a motherboard is called form factor, which affects the placement of individual components and the shape of the computer case. Therefore, they proposed to design *MotherPlant* so that the traditional function of the motherboard disappears to produce a new type of computer, one that will become a receptacle for the growth of plants and spores, alluding to mother Earth and the reintegration of the electronic components.

Besides the environmental devastations of special metals mining (Parikka 2016), electronic waste is challenging to recycle: it requires significant amount of energy and often sacrifice part of the members of our human community. *MotherPlant* is a speculative exercise on a commitment to find sustainable solutions for the current anthropocentric devastation of "mother Earth".

The non-human agency is the most obvious characteristic connecting conceptually *Génesis: dinámicas de organismos artificiales* and *MotherPlant.* However, it is interesting to observe how, in their particular ways, they merge technological aspects to eco-feminist ideas, a thinking thread systematized mainly by Maria Mies and Vandana Shiva in mid-1970´s. The authors rescued ancient culture, merging the creative (generative) and spiritual values of maternity, associating the biological roles of a mother to that of earth and, per extension, of Earth planet. Later reviews of ecofeminist thinking in the 1990´s adopted social-constructivist approaches (rather than the former essentialist and spiritual ones), being "critical of the separation of nature from culture and the hierarchical binary distinction that were built upon it." (Braidotti 2022:74)

4. Final considerations: Embracing intersectional feminist perspectives

This paper explores the intersectionality of feminist perspectives within the realm of media art, with a particular focus on the underrepresented topic of motherhood and parenting. Through examining media artworks and conducting an online survey, we aim to explore the complexity surrounding these themes and their relationship to contemporary feminist discourse, fostering a review on the concept of mother and parenting.

Our exploration highlights the historical gender gap prevalent not only in the technology sector but also in the creative industries, reflecting traditional patriarchal structures and gendered labor divisions. Despite the progress made in feminist technoscience studies and the emergence of cyberfeminism in the late 20th century, the intersection of technology and motherhood remains a relatively unexplored area within media art.

The examination of media artworks has revealed diverse perspectives on motherhood, ranging from explorations of reproductive technologies to symbolic representations of maternal relationships. They

interrogate the intersections of gender, technology, and control, provoking critical reflection on the social, ethical, and political implications of reproductive technologies. It is a starting point to reconsider power dynamics and agency within the realm of motherhood and media, even if they do not directly address the dual challenges faced by media artist mothers, who must balance the demands of caregiving and artistic production in a predominantly male-dominated field.

The complex negotiation of identity and creative expression within the context of motherhood is exemplified in the media artist mothers and their artworks brought into discussion, who managed to articulate this maternal ambivalence into the symbolic and aesthetic layers of their artistic practice. Therefore, the discussed media artworks can be considered as cultural artefacts that witness significant transformations in women's access to technological means as a form of expression, however, they also denounce the long path still to be paved to dissolve the culturally constructed oppressive structures that affect the figure of the mother and how much could be done drawing attention to ethical aspects behind reproduction technologies.

In addition, the discussed artworks with posthuman approaches emphasize the ongoing efforts to blur the boundaries between nature and technology, challenging patriarchal and anthropocentric perspectives on reproduction and ecology. They echo the overlapping of technofeminism and its nuances, showcasing technologically empowered women, and eco-feminist principles of interconnectedness and care.

Given that contemporary art and the intersection of art, science and technology is often a non-mass-market sector of the cultural industry, it is important to recognise the need for grassroots aesthetic education initiatives that provide access to technology, code and art for those who have historically been under-represented in these fields, including mothers. Through collaborative efforts and support networks, we can work towards a future where motherhood/parenthood is celebrated as a source of inspiration and innovation within media arts, enriching our understanding of technology, culture and society.

In conclusion, our examination of media artworks and ongoing research highlights the need for greater visibility, recognition and structural change in access for media artist mothers within the media arts field. By adopting an intersectional feminist approach, we can challenge dominant narratives and amplify the voices of complex identities. After visibility, these and other mother-related media artworks deserve a more accurate critical perspective to broaden and enrich the discussion.

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Exploring a Mucilage Mingle of Interspecies Incubation Assemblages[1]

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As part of the *Interspecies Incubation* PhD artistic research, the interdisciplinary artistic project *Exploring a Mucilage Mingle of Interspecies Incubation Assemblages* proposes a reconceptualization of human-centred incubation theories in the creative process by considering thinking with slime as a key metaphor for a holistic view. It aims to challenge anthropocentric thinking and create a space for dialogue and encounter with the more-than-human in order to understand the relevance of reciprocal relationships for creative processes as a collaborative act of co-emergence. *Interspecies Incubation Reactors* were conceived as sympoietic open systems consisting of networks of the multi-headed organisms slime moulds, machine-learning systems and human data, inviting the viewer to a multisensory experience. In these *Interspecies Incubation Reactors*, slime mould cultures interact with machine-learning-generated light labyrinths that represent human perception of concepts and are simultaneously influenced by visitors' movements. The slime moulds react to different light colours that influence their growth, and their surface oscillations are translated into music and visuals. As the *Interspecies Incubation Reactor* is not a closed system and is dependent on constant maintenance and care, the responsibility for the species-appropriate handling of the actors involved is emphasised. The creation of opportunities for exchange and mutual understanding between the actors through artistic and mediating formats, such as sharing and caring performances or workshops, are of central importance.

1. Introduction

The fascinating world of slime, ubiquitous yet often overlooked, not only weaves the environment around us, but it is also firmly anchored in our own existence. Iridescent slime serves as a metaphorical key that gives us deeper insights into the complex, often invisible interweavings between humans and the more-than-human. Often seen as a disgusting nuisance, slime plays an important role in nature, as is the case with slime moulds, for example. The mucus that these organisms produce makes a crucial contribution to the ecological balance by being an integral part of soil life, contributing to nutrient distribution and enabling the formation of fertile humus (Romeralo & Fiz-Palacios 2013, 167 ff.; Swanson et al. 1999, 133).

The discrepancy between human aversion and the ecological significance of slime illustrates Bruno Latour's (1988) 'great divide', which describes the profound alienation in the symbiotic relationship between humans and the environment. Theorists of new materialism, object-oriented ontology and indigenous studies, including Haraway (2018), Bar-

1. Assemblage is a philosophical concept that counters the idea of individual action, focussing on a complex network of people, things and stories that is dependent on many different influencing factors. Within this way of thinking, society is seen as something fluid and changeable, in which things and people are interlinked (cf. McFarlane/ Anderson 2011, 162 ff.).

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ad (2012), Bennett (2010), Morton (2018) and TallBear (2017), have extensively explored this alienation and its implications for the human-nature relationship (Reifer 2024, 117). The critique of notions of human superiority and the perspective of slime now serve as guiding principles in this project, in order to disguise the often human-centred creative process of idea generation with a holistic perspective and recognise the complexity and importance of symbiotic relationships. This in turn opens up space for profound questions. How can the invisible connections between humans and the environment be better understood and recognised during the creative process? How can a transformation from anthropocentric ideas to an understanding of interspecific slime communities be achieved? Here, slime brings into focus not only the rational and conscious aspects of the creative process, but, more importantly, the unconscious. The connection between slime and incubation[2] makes clear that the phases of incubation, which are characterised by unconscious and unpredictable processes during the generation of creative ideas, are closely linked to the symbiotic interdependencies and dynamics of mucilage.

This study emphasizes the importance of unconscious processes and refers to theories such as those of Wallas (1927), Haseloff (1971) and Dörner (2008). However, these theories do not take into account the complex relationships with more-than-human beings and accept their contribution as valuable co-actors. Although various incubation theorists have presented approaches that consider not only humans, but also the relationships and negotiations between humans and the environment (Dodds et al. 2002; Christensen & Schunn 2005; Sio & Rudowicz 2007), there are calls for a new construction of subjectivity as proposed by Katie Gentile in her studies on psychoanalysis (Gentile 2021, 137). Therefore, by attempting a new construction of subjectivity in the form of reconceptualising incubation, this research seeks to contribute to a more comprehensive theory of idea creation and attempts to shake up anthropocentric edifices of thought (Reifer 2024, 117 ff.). In this research these theories are subjected to a critical examination to combine them with the necessary co-operation with other species. In doing so, I try to think along the lines of slime and consider it as the key to a holistic view in order to appreciate the complexity and importance of symbiotic relationships and to question human superiority.

With these reflections in mind, my research delves into *Exploring a Mucilage Mingle of Interspecies Incubation Assemblages,* initially as a theoretical exploration of mutual interrelationships, and secondly, to investigate and understand creative processes as a joint endeavour of co-emergence with other species, particularly with the help of slime moulds. The multi-headed organisms of the slime mould (they/them) and machine-learning systems[3] play an important role as valuable co-actors that mediate at the interfaces between the different realms and forms of conscious and unconscious creativity. The machine-learning systems serve primarily as an interface between human data and slime mould, adding further perspectives to the project and recognising specific patterns that are not visible to the human eye. Moreover, these

2. Incubation refers to a process whereby conscious cognition is temporarily suspended to allow the subconscious to engage with a problem or concept (Ghiselin 1952). A well-known example is the mathematician Poincaré, who had a sudden realisation while travelling when he was not concentrating on his mathematical problem (Poincaré in Hadamard 1945, 13). Similar stories emphasise that sleep can also promote creativity. Paul McCartney of the 'Beatles' claims that the melody for 'Yesterday' came to him in a dream, and the Nobel Prize winner Loewi had the idea for an experimental proof of his theory on chemical neurotransmission in his sleep. These examples show that creative ideas often arise in moments when the mind has peace and space to work (Ritter & Dijksterhuis 2014, 1).

3. In this paper, the term 'machine-learning' is used not only because of its technical component but also to address potential confusion and mystification associated with the term 'artificial intelligence' (AI), as highlighted by the authors Daniel Leufer, Alexa Steinbrück, Zuzana Liptakova, Kathryn Mueller, and Rachel Jang on their website aimyths.org (Leufer et al. 2024, online source). The term 'artificial intelligence' can be misleading due to its historical connotations, the collaborative nature of AI development, and the limitations of current AI systems compared to human intelligence (Morozov 2023, online source). From a technical perspective, machine-learning refers to the subset of AI that focuses on developing algorithms that empower systems to learn from data autonomously and draw predictions or make decisions devoid of direct programming (Piloto 2022, online source).

systems are themselves 'holobionts'[4] of large networks of diverse data and materialities that are to be slimed by the slime mould.

To encapsulate, this endeavor is devoted to the pressing imperative of *Exploring a Mucilage Mingle of Interspecies Incubation Assemblages* as a divergent viewpoint aimed at transcending the anthropocentric framework and moving beyond the notion of individual creative brilliance, instead advocating for a humanly interconnected relationship with the Other, even within the realm of artistry. For designers and artists alike, creative processes and the incubation thereof serve as enduring companions, ripe for further evolution and alteration through mutual interaction between humans and the more-than-human world.

In the next sections of this paper, I will first consider the theoretical framework of the connection between the associative milieu and the orientation of slime and then discuss the extent to which Incubation can be located within it. This is followed by descriptions and reflections on the approach and methodology, which is primarily concerned with Donna Haraway's guiding idea of 'making kin' (Haraway 2018). Finally, there is a brief description of the artistic artefact resulting from the process and a final conclusion.

2. Engaging Slime in the Theoretical Reconceptualization of Interspecies Incubation

To respond to the anthropocentric bias mentioned above, theories of incubation are fundamentally re-conceptualised through the thinking with slime to incorporate a communal agency of the human-more-than-human. Gilbert Simondon's concept of the 'associative milieu' (Simondon 2013) provides an initial theoretical understanding of mucilaginous *Interspecies Incubation Assemblages*. This concept emphasises that individuals should not be viewed in isolation from their environment; rather, they constantly interact with it. The associative milieu corresponds to a complex field of relationships that includes the potentiality of an individual so that the rigid boundaries between people and their environment are broken down (Simondon 2013, 143; Bardin 2015, 51; Sabolius 2021, 71 ff.). The concept of 'sympoiesis'[5], which Beth Dempster developed and Donna Haraway advanced, complements this perspective and represents a counter-position to the idea of 'autopoiesis' (Dempster 2000; Haraway 2018, 85). While autopoiesis focuses on self-regulating feedback loops, sympoietic systems characterise an interdependent environment in which different species act in a cooperative and amorphous manner (Dempster 2000, 4 ff.). In such a system, each member becomes the milieu of the other, resulting in a form of shared creativity. Stacy Alaimo has also used the term 'transcorporality' to refer to the ontological perspective of the more-than-human, which occurs as a continuous structure in which bodies or entities are both distinguishable and indistinguishable (Alaimo 2008, 237 ff.). The acceptance of the diversity of transcorporeal development leads to the realisation that the human being is neither exceptional nor exclusively human; it is merely one of many entities in a world full of different forms of being (Alaimo 2008, 249 ff.; Reifer 2024, 118 ff.)

A concrete example that illustrates the orientation of slime in this discussion can be found in Wedlich's *Das Buch vom Schleim (The Book of Slime)*. Wedlich identifies the hydrogel as a substance that connects several entities and materialities. The author examines, for example, the

4. The term 'holobiont', coined by biologist Lynn Margulis in 1991, describes an association or metaorganism consisting of a complex network of different living organisms. This idea goes beyond the conventional view of individual life, as we are symbiotically connected to other organisms through the microbiome. It undermines the clear separation between subject and object and challenges our familiar concept of self (Margulis & Fester 1991).

5. The concept of 'sympoiesis' emphasises the notion that nothing exists in isolation; rather, every act of creation is dependent on a multitude of conditions and external influences. Sympoiesis highlights the interconnectedness of all phenomena, challenging the notion of individual autonomy and emphasising our inherent interdependence (Haraway 2018, 85; Gilbert et al. 2012).

extensive mucus barriers on the internal interfaces of the human body, which interact with billions of resident microbes in close cohabitation through mucus and form holobionts—units consisting of multicellular organisms and numerous microorganisms (Wedlich 2019, 81). Over millennia, slime has not only influenced the interfaces of nature, but it has also captured the human imagination. Myths and legends from various cultures often tell of the creation of the world and mankind through slimy substances and living beings. The Chinese creation story, for example, tells of the snail goddess Nü-kua who, out of loneliness, moulded man out of clay (Wilkinson 2020, 212). Another example can be found in the Hebrew Bible, which speaks of a golem made of clay and mud—an unformed figure that serves man as a mute automaton (Vudka 2020, online source). The fascinating influence of slime on the imagination can be considered in conjunction with the theories of the psychologist and academic Vlad P. Glăveanu. Glăveanu has argued that creativity "is not the product of a "disconnection", but of deeply rooted "connections" between person and environment, self and others, creator and culture" (Glăveanu 2010, 147). These examples emphasise the central role of mucus as both a physical substance and above all as a mucus metaphor that demonstrates the complexity and contradictions in the comprehensive understanding of the human and the more-than-human.

In the following, I consider how a connection between individual entities and their environments can enable the emergence of ideas and how incubation could play a key role in the creative process. The idea of the metastable[6] state—as Simondon has proposed—can in turn bridge the concepts of incubation and the associative milieu (Simondon 2008). Simondon argues that the emergence of new imaginations only becomes possible when memory images reach a state of supersaturation. The metastable state characterises a moment of intensity in the exchange between the individual and their environment. It harbours sufficient potential energy to trigger sudden changes in the entire system and thereby enable the emergence of something new (Simondon 2008, 124). In this context, the theoretical considerations of Gilles Deleuze and Felix Guattari on chaosmosis are also interesting (Deleuze & Guattari 1994, 215). According to this theory, intensive encounters with art plunge the brain into a state of chaos in which the axioms of the existing are partially suspended. Art itself is not directly chaotic; rather, it is to be understood in the sense of an ordered chaos that produces visions and sensations. This can be described as 'composed chaos', which is neither predictable nor planned (Deleuze & Guattari 1994, 204). Scientists such as György Buzsáki and J. A. Scott Kelso have extensively investigated the chaotic dynamics of the brain and the dynamics of embodied emotions, providing evidence that the brain works with non-linear dynamics (metastability) and chaotic incubation. This empirically underpins the idea of a chaotic brain in which chaos is understood not as purely random, but as an interaction between order and chaos (Buzsáki 2006; Kelso 1995; Minissale 2021, 29). In the phase of the metastable state within incubation, an epistemological space of becoming can emerge. Neo-materialist approaches clarify that, in this becoming, different phenomena are always linked and also constantly changing, but it is precisely these specific, temporary connections that comprise what we call life. The various possibilities that exist at any given moment and the fusion of social and material phenomena, which should not be understood as separate from one another, give rise to concepts

6. Metastability, originally rooted in nonlinear dynamics, is also used to describe the overall functioning of the brain. Within this metastable framework, structured routines interplay with spontaneous improvisations in different brain regions while interacting with external environmental cues (Bruineberg & Rietveld 2014, 10; Minissale 2021, 33).

such as cause and effect. In a world of constant change and diversity, however, these concepts have no clear boundaries; instead, they merge into one another. (Barad 2003, 821 ff.) Matter and materiality are therefore more than things or substances, and they must be recognised as living phenomena that are constantly changing. According to Karen Barad, this occurs through a constant process of intra-action in which they are simultaneously stabilised and destabilised (Barad 2007, 210). According to Deleuze and Guattari, the 'affective attunement' to placing oneself in the more-than-human represents processes of becoming (Deleuze & Guattari 1987, 256; Reifer 2024, 119 ff.)

These affects depend on a structural link between the species, facilitated by vibrational rhythms, which promote a form of interaction with the other:

> *"Rhythm is the milieus' answer to chaos. What chaos and rhythm have in common is the in-between—between two milieus, rhythm-chaos or the chaosmos. [...] In this in-between, chaos becomes rhythm, not inexorably, but it has a chance to. [...] There is rhythm whenever there is a transcoded passage from one milieu to another, a communication of milieus, coordination between heterogeneous space-times." (Deleuze & Guattari 1987, 313)*

This artistic investigation focuses particularly on the transitional phase of the slimy 'in-between' as a potential realm for interspecies creativity. By immersing oneself in the process of becoming through incubation, it's possible to foster a deeper connection with other beings, potentially cultivating greater empathy towards them. In the ensuing exploration, this research uses an artistic methodology to engage with slime moulds and machine-learning systems, demonstrating how such *A Mucilage Mingle of Interspecies Incubation Assemblages* can be artistically explored, with a focus on the formation of slime.

3. Forging Kinship: Discovering Slimy Interspecies Incubation in the Creative Process

The methodological approach to the artistic examination of *Exploring a Mucilage Mingle of Interspecies Incubation Assemblages* involves several steps, ranging from scientific research in the classical sense to artistic research, culminating in a speculative apparatus.[7] The first part of this project consisted of a comprehensive literature review and the analysis of psychological incubation theories in the form of diagrams, and its aim was to conduct an initial deconstruction of the theoretical approaches. This resulted in a total of five quintessences: network activation spreading, forgetting, external stimuli, relaxation and chance (Reifer 2024, 120 ff.). These quintessences were created primarily for the purpose of orientation and are used as so-called 'enabling constraints' (Manning & Massumi 2014, Rousell 2018) to enable focus and divergent thinking within certain parameters. These open restrictions can thus enable the emergence of something new (Manning & Massumi 2014, 93). In this study, these enabling constraints in the form of quintessences were starting points for expert interviews with slime mould and machine-learning researchers; these interviews established common considerations regarding *Exploring a Mucilage Mingle of Interspecies Incubation Assemblages* and suggested approaching the similarities and differences of the respective actors in the milieu of incubation.

7. In order to elucidate the diverse interconnections of the incubator, this study proposes an adaptation of the technofeminist concept of the apparatus as a material-discursive entity (Haraway 1995, Barad 2007), used as both a theoretical framework and a speculative tool (Barla 2019). On the one hand, this approach seeks to elucidate narratives about the intertwined nature of technological and organic entities, unravelling specific socio-political, economic, and historical complexities while promoting discussions about processes of emergence. On the other hand, the use of the apparatus as a speculative method aims to construct assemblages of the more-than-human, thereby challenging and reshaping anthropocentric notions of inequality (Reifer 2024, 129).

The challenge here was also not to anthropomorphise the co-actors involved—including slime moulds and machine-learning systems—but to free them from the passive role of the exploited other.

In the second part of the project, the focus was intensive examination and experimentation with *Physarum polycephalum* (slime moulds) and machine-learning devices, and the goal was to become related to these actors. This requires a form of communication, as Starhawk (2004) has noted. She emphasises that the development of the ability to communicate with nature first requires an ontological shift so that the possibility of such communication can be recognised. She draws on the myth of bird language to illustrate that understanding natural languages begins with recognising them as such; it is then possible to listen attentively (Starhawk 2004, 7 ff.). Subsequently, alternative ways of knowing can be acquired through the practice of listening (Neimanis 2012, 13). The geneticist and biologist Barbara McClintock emphasises how crucial it is to develop a connected perception of an organism and to have the patience to be attentive to what the being or the material wants to communicate (Sheldrake 2020, 106).

This type of communication is used in this research project with the help of mucus as a metaphor for complex, symbiotic interdependencies to gain different insights into and approaches to understanding communication with more-than-human entities. One example of this is the slime of snails. The mucus trail alone conveys all the necessary information to attract a potential mate, such as species, sex or even attractiveness. In some species, this trail is even transformed into a gender-neutral mucus to avoid intrusive male suitors (Wedlich 2019, 67). If a mutual understanding is reached, slimy love arrows are exchanged with tantalising pheromones. The remaining mucus is also attractive prey for ants, but this can be to the ant's disadvantage. This mucus can harbour a parasite, such as the small liver fluke, which grows in the ant's body and ultimately takes control of its central nervous system, transforming it into a zombie ant that is doomed to die (Wedlich 2019, 200).

Another example, from the realm of slime which is particularly relevant for this research project, are slime moulds, which are multi-headed organisms. Slime moulds are also referred to as social amoebae (Bonner 1995, 165) and, due to their ability to constantly change their shape like the Greek sea god Proteus, they are also known as *Proteus animalcule* (Rösel von Rosenhof 1755, 621 ff.; McAlpine 1881, 17). They consist of a sac of amoebae surrounded by a thin mucus envelope; they have no distinct shape, but they behave intelligently, despite lacking both a brain and a nervous system (Bonner 2009, 52). Slime moulds are organisms that develop from a seemingly uncoordinated group of genetically identical individual cells into a strangely decentred structure with organismic functions that are characteristic of multicellular species with different tasks and continuous life cycles (Bonner 1995, 3 ff.). Slime moulds are living, changing, identity-varying, strange organisms. Collective behaviour plays a particularly important role in the migration and reproduction processes of slime moulds. This is because individuals that previously lived independently interact with each other and work together to achieve a common goal: the search for suitable conditions for their survival and the spread of their spores (Reid & Latty 2016, 799). In recent decades, slime moulds have attracted particular attention in entrepreneurial techno-sciences because of their astonishing behaviour, with negative consequences. Techno-scientists use them

for capitalist purposes, including in the form of experimental efficiency bodies. For example, slime moulds have been used to build robots and have been grown on chips to measure electrical voltages. They were also triggered with direct bright light to define the direction of robots' movement (Grube 2016, 28 ff.; Mitsch 2020, min. 46). Direct, bright white and blue light are harmful stress factors for slime moulds and trigger avoidance reactions (Häder & Schreckenbach 1984, 55 ff.; Briard et al. 2020, 3). In another application, slime moulds were used to predict Mexican migration patterns in the US (Adamatzky & Martinez 2013, 242 ff.). However, the extraordinary abilities of slime moulds have been described as examples of primitive intelligence, which in turn illustrates the anthropocentric supremacy in the species hierarchy (Bahng 2017, 320; Reifer 2024, 121 ff.) This raises the question of how it is possible to treat organisms used in artistic research processes in a species-appropriate, ethical manner.

An essential component of this artistic project therefore relates to the special care of slime moulds as independent actors in the overall artistic structure. For Juno Salazar Parreñas, cross-species caring is a kind of 'decolonial strategy'[8] that attempts to resist the separation of the human and the more-than-human and to explore caring and relational ways of being in the world (Parreñas 2018; Kaner 2022/23, 27). Like Parreñas, Jane Bennett emphasises a responsible, strategic and sensitive approach to material things and non-human actors (Bennett 2010, 116). To overcome political challenges, she believes that people must develop an ecological sensitivity to material things. Sensitivity, mindfulness and respectful interactions with the more-than-human are central concepts in the discussion about care work (Bennett 2010, 103 ff.). This approach is based on, first, a heightened awareness of human actors with regard to other actors in a network without hierarchies and, second, the realisation that network compositions are diverse and can be changed (Bennett 2015, 84; Peters 2018, 24; Reifer 2024, 122 ff.)

As an artist who has spent the last two and a half years intimately involved in the observation and care of various species of slime mould, I've noticed the emergence of environments characterised by care, empathy and sensitivity. This notion of care not only fosters alternative perspectives that challenge colonial power structures but also inspires imaginative explorations of interconnectedness and kinship, echoing Donna Haraway's notion of living and perishing together in unpredictable societies (Haraway 2018, 137 ff.). Through encounters with others and the attentive care of different species, I've imagined possibilities for building meaningful relationships and mutual understanding. Sharing these insights and experiences, including the act of caring for other beings, is crucial to fostering deeper connections and promoting societal well-being. To disseminate these ideas, workshops have been organised at various universities and exhibitions, such as the *AI+ Artificial Intelligence and Art* 2024 at Splace Linz, as well as a *Caring and Sharing* performance at the *Ars Electronica Festival* 2023. Through these efforts, I hope to provoke reflection and inspire action towards a more caring and connected world.

Due to their special characteristics and similarity to biological incubation networks, slime moulds appear to be ideal actors to challenge the human imagination of incubation and redefine the understanding of community and cooperation in nature. This could result in profound experiences and insights into the relationship between humans and na-

8. In order to embark on decolonization, it is essential to adopt a dual perspective that acknowledges unique historical, geographical and political settings while facilitating cross-comparisons with alternative decolonizing methodologies (Parreñas 2018, pos. 522). Care work, which is deeply rooted in feminist scholarship, constantly grapples with power dynamics, inequalities and instances of violence, yet remains inextricably linked to labour. Particularly in the technosciences, there is a growing emphasis on the importance of care in shaping knowledge production (Parreñas, 2018, pos. 3575; Reifer 2024, 129).

ture that go beyond conventional, anthropocentric views. Although only part of the slime moulds' experience can be understood by observing their behaviour and following their tracks, their unconventional behaviour could contribute to understanding the creative incubation process as a collaborative slimy act of becoming between different species. The philosopher Steven Shaviro has noted that the difficulty of comprehending others' experiences also applies to one's own self-reflection, and he has argued that sentience and consciousness are essentially based on fiction and stories (Shaviro 2016, 215; Reifer 2024, 121 ff.) The study of slime moulds, therefore, not only broadens our understanding of incubation processes and the natural world but also prompts profound questions about the nature of our own encounters and perceptions.

The inclusion of machine-learning in the context of *Exploring a Mucilage Mingle of Interspecies Incubation Assemblages* is also highly important, as in today's world, machine-learning systems are deeply integrated into the processes of life and creativity. They collect data from different sources — often at the expense of communities and ecosystems[9] (Crawford 2021; Kannengießer 2022, 56 ff.; Hepp et al. 2022, 457) — and process huge amounts of data to recognise patterns and make predictions. Machine-learning systems are thus part of a deeply rooted 'data colonialism' (Turow 2021), and they can also be regarded as 'toxic bodies'[10] in the sense that Stacy Alaimo has described (Alaimo 2008, 259). The term toxic bodies is not limited to human bodies; it refers to all bodies, including machine-learning systems. According to Alaimo, the conscious inclusion of toxic bodies can contribute to understanding oneself in constant exchange with the environment and to imagining an epistemological space that takes into account both the unpredictable becoming of other living beings and the limits of human knowledge (Alaimo 2008, 262; Reifer 2024, 125 ff.) Like Alaimo, the philosopher Rosi Braidotti does not advocate technophobia as an appropriate approach and instead suggests that a balanced position should be taken that is neither fearful of technology nor blindly technophilic. It is a matter of being sensible enough to face the challenges posed by human historical development (Braidotti 2002, 146). The authors Jason Edward Lewis, Noelani Arista, Archer Pechawis and Suzanne Kite have suggested a deeper connection to machines by drawing on indigenous epistemologies. They recommend an expanded circle of relationships that considers machine-learning systems, for example, as 'Alna' (derived from the Hawaiian term for land, 'aina'). This term is intended to emphasise that these relationships should be respected as much as all other aspects of the network of life (Lewis et al. 2018, 4). They also emphasise that machine-learning systems are always interwoven with their physical materials and resources. Separating the devices from their matter would sever this connection. The relationships to the machine-learning systems are therefore always also connections to exploited resources. An ethical approach requires a critical review of the ontological status of each part that contributes to these systems (Lewis et al. 2018, 11). The comprehensive analysis of machine-learning systems requires not only the consideration of their physiological materials, but also a critical examination of the underlying infrastructural networks. These deeper structures play a decisive role, as they are often what make the impact of machine-learning systems possible in the first place (Hepp et al. 2022, 457). These findings clarify that machine-learning systems are not only toxic actors, but they also actively operate at the interface between hu-

9. According to a study by the University of Massachusetts, a training process for such a system emits more than 626,000 pounds, or the equivalent of more than 283,000 kg of CO2. This corresponds to the lifespan of five US vehicles (Hao 2019, online source). This is accompanied by high water consumption and the subsequent marginalisation of indigenous tribes. Switching to renewable energy for data farms by using lithium batteries would continue to have major negative side effects (Jones & Easterday 2022, online source).

10. Bodies marked by toxicity are created by a confluence of factors, including scientific advances, industrial practices and consumer habits. Far from being static, these bodies are in constant flux. Their complexity stems from the absence of clearly defined boundaries, with influences from scientific, medical and various societal factions shaping our understanding of them. While toxic bodies carry negative connotations, they play a crucial role in feminist discourse by moving away from a simplistic dichotomy between nature and the body. Instead, they highlight the interconnectedness of environmentalism, health advocacy and social justice (Alaimo 2008, 261 ff.).

mans and the environment. As mediators in E*xploring a Mucilage Mingle of Interspecies Incubation Assemblages*, they contribute to gaining new insights into the multi-layered relationships between different entities by analysing data and recognising patterns. In this way, machine-learning systems act as speculative entities in the complex incubation network and open up additional ways of thinking.

In this context, the close connection with living and machine actors, which Anna Tsing has referred to as 'contaminated collaboration', is also used in this project with the metaphor of slime, becomes particularly significant. These actors represent unpredictability, transgression and non-alignment with capitalist interests, and they produce patterns of unintentional coordination in an uncertain environment (Tsing 2018, 40). Haraway has expressed similar views in her revision of the cyborg figure, describing cyborgs as imploded entities that express specific, diverse relationships; they are ontologically heterogeneous and historically situated (cf. Haraway 2012, 301). In this context, the author Merlin Sheldrake has argued that all entities, including humans, can be regarded as 'symborgs' or 'symbiotic organisms'. This fusion of life forms and technical apparatuses, whether biological or artificial, emphasises the common existence of humans, nature and machines in a constantly evolving network of relationships (Sheldrake 2020, 141). To summarise, this research project on *Exploring a Mucilage Mingle of Interspecies Incubation Assemblages* should provide deep insight into the complexity of interactions between different actors and demonstrate the need for a holistic view of humans, nature and technology.

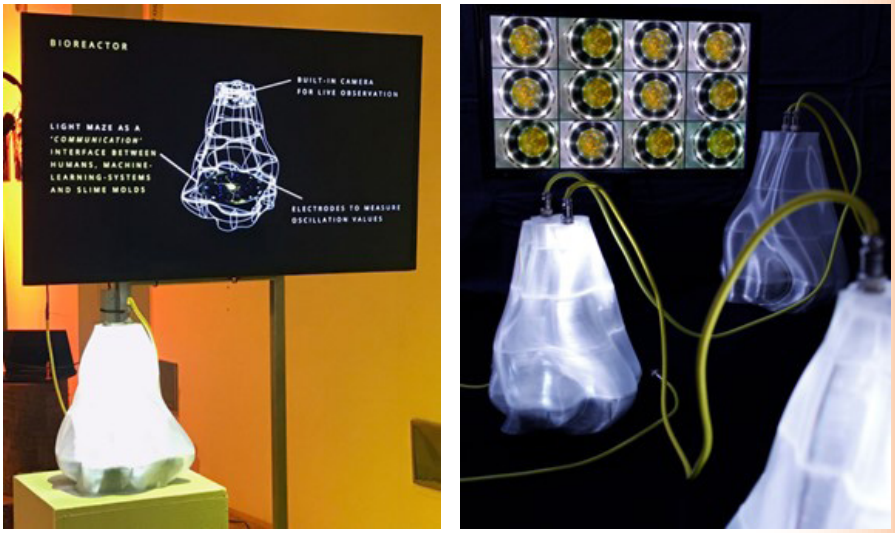

Fig. 1. and 2. The left-hand image shows one *Interspecies Incubation Reactor* and the technical sketch with the respective functions at the *AI+ Artificial Intelligence and Art* 2024 exhibition. Three *Interspecies Incubation Reactors are displayed* with images from inside the reactors on the right-hand side. (source: Martin Zeindl & Nadja Reifer 2023/2024)

4. Artistic Manifestations: Exploring a Mucilage Mingle of Interspecies Incubation Assemblages

A comprehensive review of existing literature alongside an examination of psychological incubation theories formed the foundation of this artistic inquiry. Experimental interviews with experts in slime mould and machine-learning research, combined with extensive exploratory and practical work, led to the creation of a speculative incubation apparatus, complemented by further experimentation. The outcome of this creative process is the development of several *Interspecies Incubation Reactors*, designed to render the intertwined processes of incubation pal-

pable through a collaborative, artistically speculative exchange involving both mechanical and biological agents (Dunne & Raby 2013). The objective is to establish a kind of communication interface bridging rational machine-learning systems, the unpredictable biological subconscious of slime moulds (*Physarum polycephalum*), and human data. Each I*nterspecies Incubation Reactor* comprises a culture of slime mould and a light maze generated by machine-learning systems (specifically, Orange by Demšar & Zupan). The subdued light mazes represent human perceptions derived from sentiment analysis of diverse internet posts, with this human data transformed into a multidimensional scaling dot plot of light. Slime moulds exhibit varied responses to different light colors, thereby influencing their growth patterns. Surface oscillations of the slime moulds are measured through biodata sonification[11], with the resultant data converted into MIDI signals and further translated into rhythmic visualizations and music (Reifer 2024, 126 ff.). Through the creation of *Interspecies Incubation Reactors*, this project aims to redefine incubation processes by engaging both machine-learning systems and slime moulds in a collaborative artistic dialogue. By transcending anthropocentric perspectives and fostering connections between human data, biological organisms, and mechanical agents, it challenges traditional notions of incubation and invites a more inclusive understanding of creativity and knowledge production.

This artistic exploration is an attempt to convey sensual-aesthetic rhythmic experiences with the more-than-human in a symbiotic way. The aim is to reconceptualise the concept of creative incubation and to open it up to the uncontrolled and unplannable. Slime itself is not linear, and the creative process does not follow a fixed pattern, either. An exploration of different notions of time is necessary to consider incubation not only as a phase of the creative process, but also as the centre of the slime. Incubation can occur in any traditional phase of the artistic process: idea generation, when one is stuck, while waiting for slime moulds to grow and provide answers, or in the versatile translations of machine-learning systems that capture the uncontrollable. Incubation describes the lively events in the creative process, which is characterised by active and quiet phases, conscious and unconscious processes and a newly materialistic action that goes beyond the purely human—a continuous process with constant impulses from the environment.

The implementation of communication interfaces creates a space that allows people to connect with their own animalistic, slimy nature. This process is facilitated by observing other entities and especially by active listening, as Astrida Neimanis has emphasised (Neimanis 2012, 13). In this project, observation and listening not only include human sensory experiences and perceptions of time, but they also integrate the perspectives of other actors, as well as their own way of interpreting data and perceiving time.

Furthermore, in this context, the machine-learning systems function as a kind of communication interface between human Internet data and slime moulds. An image analysis was conducted of the slime mould structures grown through the light labyrinth. The fact that the resulting data of these image analysis influenced the concepts of the next light labyrinth that was generated resulted in a continuous process that was subject to dynamic tensions and changes. In summary, the *Interspecies Incubation Reactors* were used in an attempt to implement dynamic en-

11. Biodata sonification is the conversion of information extracted from natural sources into audible signals. This technique allows environmental or biological data to be presented in an auditory form, aiding studies in areas such as acoustic soundscapes, ecology and interspecies communication (Cheng 2022, 3).

tanglements in the form of various entity assemblages and make them tangible by means of various outputs, such as rhythmic visualisations and music.

Fig. 3. and 4. Both images show impressions of the *Sharing and Caring* performance during the *Ars Electronica Festival* 2023 (Source Images: Alexandra Kraler, Tina Frank, and Nadja Reifer 2023).

Further exploration with the *Interspecies Incubation Reactors* is anticipated in the future, although they are briefly outlined here due to their ongoing development. Attempts will be made to involve humans in various ways to contaminate them consciously and unconsciously with the mucous rhythms. The primary focus is the incubatory interstices of more-than-human encounters, which are intended to promote a mode of knowledge production. One example of this is the attempt to make the contamination of a physical unconsciousness tangible through a trance dance performance. Another approach is to investigate interspecific encounters by speaking with the slime moulds. The users of the experimental set-up can record their voices, which play back at a specific time depending on the growth of the slime moulds. This allows the experimenters to become part of the musical performance. The final experiment involves linking the *Interspecies Incubation Reactors* with a virtual reality (VR) application. While the experimenters can immersively experience the visual and auditory fractal rhythms, the coordinates of the mostly unconscious movements are recorded and transferred to the light labyrinth. This creates reciprocal rhythmic contact between the different actors (Reifer 2024, 127). These experiments aim to blur the boundaries between human and non-human actors, challenging traditional notions of agency and participation in creative processes. By exploring the potential of interspecies collaboration and immersive technologies, this research seeks to push the boundaries of artistic expression and knowledge production.

5. Conclusion

In conclusion, this interdisciplinary research project, *Exploring a Mucilage Mingle of Interspecies Incubation Assemblages*, aims to create a space for dialogue and encounters with other species and materials in an incubator environment, while at the same time contaminating the subconscious with interspecific rhythms. By focusing on slime, the project explores the profound implications of this seemingly ubiquitous but often overlooked substance as a metaphor for complex symbiotic interdependencies. This perspective reveals that slime serves not only as a physical substance, but also as a metaphorical substrate that demon-

strates the fusion and contradictions within human and non-human relationships. Furthermore, the project goes beyond mere observation by actively experimenting and engaging in speculative dialogues with slimy organisms such as Physarum polycephalum (slime moulds) and machine learning devices in an incubatory space. In this process, empathy and awareness are central principles that are fostered in a networked, co-emergent environment. As an open system that relies on constant maintenance and care, the Interspecies Incubation Reactor emphasises the responsibility for appropriate engagement with all actors involved and aims to deepen the human understanding of care in relation to the more-than-human. Creating opportunities for exchange and mutual understanding between actors through artistic and mediating formats, such as sharing and caring performances or workshops in academic settings, is crucial. Furthermore, the study aims not only to make new narrative forms of symbiotic interdependencies tangible but also to reformulate them theoretically by focusing on slime. Machine learning systems play a significant role in these assemblages by enabling the discovery of collective maze structures based on extensive human datasets, allowing for unique interactions with slime moulds. Furthermore, these systems offer alternative perspectives by recognising patterns that may elude human perception. By combining scientific research and artistic practice, the project offers an alternative approach to slimy interspecies incubation assemblages. In particular, it emphasises the dynamic entanglements of different entities with subjectivity and the importance of empathy, responsibility and mutual understanding to create deep connectedness. Understanding the significance of reciprocal relationships in creative endeavors is essential, framing them as communal acts of co-emergence alongside other species. Through the interdisciplinary approach of relational thinking, the project offers valuable insights into the dynamics of interdependence and the possibilities for fostering symbiotic relationships in a world of interspecies coexistence.

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Mother Bear Mother Hen & Rattlin' Bog: Activating Critical Making, Art Hack Practice & Ludic Modalities in Developing Interactive & Virtual Reality Artworks

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Mother Bear Mother Hen and Rattlin' Bog are two interactive artworks that integrate physical computing with screen-based content compiled and coded in the Unreal game engine. Both were produced between 2020-23 through Epic MegaGrant funding and with undergraduate research assistants. The *Rattlin' Bog* installation sends signals to code through conductive materials embedded in a detailed laser-engraved sculptural interface. Animal characters onscreen interact with one another and with their bog environment. *Mother Bear Mother Hen* connects wearable bear and chicken jackets to a virtual reality game through serial communication. Real-world stomping is transmitted to the game and results in player movement. Light and sound are output through the jackets as reactions to the gameplay. Both artworks activate 3D modelled and animated animal characters to construct narratives about social and environmental systems. This paper discusses ways in which the artist and her team utilised critical making, art hack practice, and ludic modalities in producing these projects.

1. Introduction: Critical Making, Art Hack Practices and Ludic Modalities

Creating a 3D experience with a game engine requires multiple skillsets including character design, modelling, rigging, animation, storytelling, sound design, and games programming. To add a layer of bespoke physical interactivity, a practitioner must design and construct an interactive device and integrate it into the screen-based content using microcontrollers, sensors, and serial communication. The projects presented in this paper employ these and other modalities that combine screen-based and 3D making and troubleshooting skills.

The author-artist created two projects that combine Unreal Engine software with physical computing over a three-year period funded by an Epic MegaGrant titled, "Interfacing Unreal with Physical Computing and New Media VR Pedagogy"[1]. *Mother Bear Mother Hen* integrates a virtual reality (VR) game with wearable sensory jackets and *Rattlin' Bog* is an interactive installation that includes a digital fabrication component with conductive inputs. Creating these works involved iterative processes of play, critical making, and art hack practices by the artist and her teams. The final projects incorporate 3D-modelled animal characters

1. Research website link: https://blurringartandlife.com/interfacing_unreal_physcomp/

Keywords Physical Computing, Critical Making, Art Hack Practice, Play, Virtual Reality, Interactivity, Digital Fabrication.
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and environments that, through viewer-participant interactivity, construct narratives around social and environmental systems.

To create *Mother Bear Mother Hen* and *Rattlin' Bog*, the artist and her undergraduate research teams engaged in configuring materials and code that would connect microcontrollers to the Unreal Engine, create unique experiences for viewer-players, and present concepts about 21st life that build empathy, contemplation, and consideration. Through these processes, the bounds of the technologies were tested. Nora O'Murchú writes that,

> *As technology plays an increasing role in our lives, artists are undertaking a process of opening up and extending our critical understanding of it. Engaging in processes of making and tinkering, artists are experimenting with material arrangements of data, algorithms, hardware and software to articulate particular stances and ideas through their production, and by making transparent the processes and thoughts that underpin their construction. (O'Murchú 2020)*

In art hacking events, artists and makers work collaboratively to create projects over a short time frame. Suzy O'Hara and the author-artist wrote that, "Artists are accustomed to thinking laterally and applying art-making methodologies across a variety of media. During an art hack, this occurs through experimentation with media and materials as part of the phases of project conceptualisation, prototyping and execution." (Bradbury and O'Hara 2016) This collaborative modality can also be applied to creating artworks over a longer span of time, with the same spirit of experimentation with concepts and materials.

Over the past two+ decades, artists have been creating alongside the infrastructure and tools lauded by the Maker Movement (Maker Faire, n.d.). They have done so while continuing to explore emerging and traditional methods of constructing sculptural, digital, and interactive interfaces for artworks that present critical social, political, or aesthetic ideas. In Garnet Hertz' 2012 interview with Matt Ratto, who coined the term *critical making*, Ratto states, "...making is a deeply conceptual activity, and deeply reflective, though not necessarily in the same way as critical thinking." (Ratto 2012) Making requires a knowledge of materials, gained through prior making, paired with an ability and willingness to play with combinations of materials that the practitioner may not have tried before.

Derek Ham writes about the importance of playfulness, or the ludic, in the design process, stating,

> *Many design methods begin with some element of play through the game of "seeing with the eye." Others might argue that play is involved from the initial process of creating things with your hands, building models, or even drawing. Then there are those who might say play is involved when they imagine themselves inside their creations while they are looking at a scaled model, a drawing, or a digital walkthrough. Play allows us to create in intuitive ways. It provides for moments of reflection and whimsical imagination. It is the key to being creative. (Ham 2016)*

During the production of the two artworks discussed in this paper, the teams maintained a playful outlook through troubleshooting the technologies and testing the aesthetic and conceptual directions of the

projects. Through rounds of designing and testing, configuring, and animating, the makers maintained an attitude of playfulness that is evident in the final project versions.

Using the *Mother Bear Mother Hen* and *Rattlin' Bog* projects as case studies, this paper presents the finished artworks, discusses the materials and modalities involved in their production, and relates research on critical making, art hack practices and play to the implementation of each.

2. *Mother Bear Mother Hen*

2.1 The finished artwork

Mother Bear Mother Hen[2] is a VR game with accompanying jackets that become part of the user interface. The bear and chicken jackets embed soft circuit sensory inputs and outputs, including stomp detectors, LEDs, and a mini speaker, all connected to the game through an Arduino Uno-style microcontroller, custom Unreal blueprint programming, and serial communication.

Fig. 1 Player, as the bear, peers into the chicken coops by opening the coop door with truncated bear hands.

When a viewer-player approaches *Mother Bear Mother Hen* in an installation context, they choose to wear either the chicken jacket or the bear jacket with the VR headset and controllers and then play the game in first person as their chosen character (Fig. 2). The jacket reacts to the gameplay and serves as an input device. Motion detectors strapped to the knees translate stomping movements and progress the player forward in the game. Lights and a speaker sewn into the jacket with conductive thread react to in-game experiences and light up or make sounds to indicate success or difficulty during gameplay. The jackets make the VR gameplay more performative for the player, who can hear the audio and experience the feedback from their stomping motion. The jackets also create a spectacle for non-playing viewers who see the costumed player as a reflection of the first-person character in the game.

The *Mother Bear Mother Hen* gameplay begins with a menu screen where the player selects which character they will embody: Mother Hen or Mother Bear. An omniscient narrator is heard providing vocal cues

2. Link to project website: https://blurringartandlife.com/vb/motherbearmotherhen.html

to guide the player through the story. He gives them auditory 'nudges' if they are not responding to visual cues. As Mother Hen, the player begins in the coop yard and then moves inside the coop, where they see three other hens roosting in nesting boxes. These hens are having a conversation about childbirth (egg laying) as they sit on their eggs, at times disparaging the player for her maternal negligence. Soon, the eggs in the fourth nesting box hatch and baby chicks (presumably belonging to the player) begin running around the coop floor. At the same time, a bear who has been lurking around the coop begins reaching in and grabbing at the baby chicks, trying to collect them (Fig. 4). A timer begins and the player, as Mother Hen, must grab her chicks and move them out of the bear's reach to 'win' the level. If she wins, she roasts one of Mother Bear's cubs over a fire. If she loses, she manifests in Mother Bear's kitchen, where she sees her chicks being boiled.

Fig. 2 [L] Player wearing bear jacket during gameplay. [M] Player wearing chicken jacket during gameplay. [R] Chicken jacket detail with Arduino Uno-style microcontroller and speaker.

As Mother Bear, the player begins in a kitchen and her two cubs enter the room complaining that they are hungry. The player leaves her home in search of food for the cubs. When she exits the kitchen door, she is teleported to the outside of Mother Hen's coop. After exploring the coop (Fig. 1) and knocking down a fence to enter the yard, the player notices baby chicks running around. The narrator enthusiastically encourages the player to grab the chicks. If Mother Bear is successful at gathering three chicks, she teleports back to her kitchen, where she boils the chicks in a pot for her cubs to eat. If she is not successful at grabbing enough chicks, she finds herself in the chicken yard where one of her cubs is being roasted over the fire. There is cartoonish violence in the game as the character who 'wins' essentially cooks the young of the other player.

Throughout the VR gameplay, the player moves through a story of antagonism and survival between a hen and a bear parent and their chicks and cubs. This game was developed during the COVID-19 pandemic, when lockdowns and remote work put caregivers into challenging circumstances (Bradbury 2022). Emotions were high between people not being able to access childcare to continuing pressures of work and productivity. When lockdowns and restrictions were lifted, many childcare facilities had shut down due to precarious financial support (Miller 2021). This left many without access to care, a problem that continues today. Parents were faced with providing remote learning to their school age children while schools opened and closed intermittently, with con-

tinued concerns about illness for themselves and their families. Rather than a robust social safety net stepping in to support caregivers and children (at least in the U.S.), individuals were left to fend for themselves to find childcare and keep their jobs, often at the expense of access to care for other children. The VR game *Mother Bear Mother Hen* aims to create empathy and visibility by placing the player in the desperate role of a caregiver tasked with protecting and/or feeding her children at all costs. Visually, the two cel-shaded levels in the game create a dream-like environment in which a player confronts a lose-lose situation that tests her fortitude and ability to survive and thrive.

2.2 The production process

Ludic modalities were present in the production of *Mother Bear Mother Hen*, particularly in creating and testing the bear and chicken jackets. The lead artist created these jacket-input-devices starting with found and thrifted extra-large jackets that would fit a range of players. For the chicken jacket, the artist sewed over 100 feathers from different types of fabric that were then machine and hand-appliqued to the jacket. Beads were sewn on top of the feathers to add detail and texture (Fig. 2, R). Sewable Neo Pixel LEDs were stitched to the jacket lapel and wired to an Arduino Uno-style microcontroller using conductive thread. A STEMMA (Adafruit n.d.) speaker-amplifier was stitched with conductive thread to the Arduino. This system was programmed so that the light and sound outputs would be visible and audible through the closed system of the jacket. The bear jacket was constructed similarly, although a faux fur coat (inherited from the artist's grandmother) was used as the base and a lapel was created to hang over the shoulders and around the back of the jacket (Fig. 2, L). The LEDs, speaker, stomp detectors, and Arduino Uno were sewn to the lapel so that this system could be modular and removed should the jacket need to be replaced.

Fig. 3 Play testing Mother Bear Mother Hen in the New Media VR Lab at UNC Asheville with the lead artist [R] and game developers Thomas Townsend [M] and Sarah Hendricks [L].

Connecting the Arduino code to the VR game and adding the stomping input was one of the most complex and playful challenges undertaken in the production process. Many Sundays[3] were spent in the lab (Fig. 3) with the Unreal programmer, Thomas Townsend and the special programming assistant, Nolan Scobie, first making the communication between Unreal and Arduino possible and then troubleshooting the stomp mechanic between Arduino and Unreal. A motion detector is strapped to a knee of the player so that when they engage in a stomping motion, the Arduino receives notification. The Unreal Blueprints receive this data (through serial communication) and replace the teleport trace in VR to cause the player to move forward. Because the player is stomping with their own body, this forward movement in the game does not cause them to feel unsteady, as their body expects this sensation.

Creating the narrative VR gameplay involved a standard game development process of ideation, storyboarding, and character development. The character design, modeling, rigging, and animation were led by team member Clara Tracey with assistance from Keithon Turner. Play testing the game was important to finesse the layout and timing (Fig. 3). This was particularly key for the heightened part of the gameplay in which, as Mother Bear, the player tries to catch as many baby chicks as possible during a timed segment and, as Mother Hen, they try to keep the chicks from being caught by the bear (Fig. 4). The Level Sequencer in Unreal Engine 4 was critical to developing parts of the game that acted as "cut scenes," or sections that established the non-player characters (NPCs), the story, and the mission of the player as the first-person character.

Fig. 4 Bear grabs at chicks inside the coop. Player is embodying the Mother Hen character here and trying to keep her chicks from being grabbed by the bear.

The *Mother Bear Mother Hen* game sits within the horror genre. There is a feeling of suspense as the player navigates the darkly lit levels. Al-Zubeidi, DeLaney, and Seo discuss the elements that created a sense of unease in the VR game "A Walk Alone." This game intends to help players empathize with the fears that some women experience when they walk home alone at night. They state that in developing "A Walk Alone" that, "...our main takeaway consisted of dimly lit environments and eerie sound design to elicit emotional unease from the viewer." (Al-Zubeidi et al. 2022) This strategy was also used in the production of *Mother Bear Mother Hen*. The character design and lighting complement David Freund's sound design and composition to create suspense for the player. Humorous and playful aspects are also present in *Mother Bear Mother*

3. Sundays are mentioned here to underscore that extensive time was spent on this troubleshooting process that extended beyond conventional business hours. The programming assistants were paid for their time on the project regardless of the days of the week worked.

Hen. Some of the horror elements, including the bear and hen's first-person arms with exposed bone and flesh (Fig. 1), and a hard-hearted hen smoking a cigarette, play into this effect that is both eerie and absurd.

2.3 Critical Making and *Mother Bear Mother Hen*

In devising and designing *Mother Bear Mother Hen*, the artist aimed to create an experience that is both serious and playful while telling a compelling story and creating empathy in a viewer-player. She also aimed to create an artistic game that considered viewer-player embodiment both inside and outside of VR using costumes that connect to the gameplay through physical computing inputs and outputs. While these aims were clear, achieving them would require her to apply existing skills, build new combinations of technologies and tools, and guide a team of undergraduates to do the same. Through this process, the project would innovate by creating new modalities of connecting physical computing with VR and by telling stories from a caregiver's perspective that don't make their way into mainstream game media.

In A *Mini Review of Presence and Immersion in Virtual Reality*, Wilkinson, Brantley, and Feng consider the use of multi-sensory feedback in VR to increase immersion, stating,

> *One way to enhance presence is to increase immersion. [...] Multi-sensory feedback is also another way to increase immersion. [...] The use of haptic feedback is now commercially viable and may serve as another sensory feedback system to supplement traditional visual and auditory stimuli. It is also possible to create haptic feedback outside of the VR environment. (Wilkinson et al. 2021)*

In *Mother Bear Mother Hen*, bespoke jackets serve as input/output devices that have the potential to increase immersion for the viewer-player during gameplay. They also allow the immersion in the game to begin *before* entering VR through the act of putting on the jacket. The immersive experience is simultaneously increased for the non-playing audience; they observe the VR gameplay on an adjacent monitor but can also enjoy seeing the player in the jacket as they stomp and the LEDs light up and the speakers output reactive sound (Fig. 5).

Fig. 5 Player in bear jacket and crowd viewing onscreen gameplay and player performativity at the New Media Caucus's *Future Bodies Symposium Exhibition* at Virginia Tech. September 2022.

Garnet Hertz writes in the Introduction to *Critical Making*, that, "I generally think that innovation occurs out of pouring your ideas and processes into a field that you're not familiar with, and actually doing this on a regular basis is a crucial part of practicing inventiveness" (Hertz 2012). Creativity emerges from a process that centres making. The artist and team creating *Mother Bear Mother Hen* were guided by a storyboard and technical goals, but it was the iterative process of making the game and the jacket accessories that led to the aesthetic and material combinations that comprise the final artwork.

The experience of the viewer-player is important to consider when developing virtual reality works because of the possibility of nausea or unease when in the VR space. People who enter VR are taking their understanding of the physics of everyday reality with them into the game. A critical understanding of this can help a VR artist/designer/developer to draw upon the viewer-player's bodily knowledge of physics to create a new experience in VR that isn't possible in day-to-day life. David Chalmers states that, "Virtual reality takes the immersiveness and interactiveness of everyday reality and brings in the role of the computer in generating this reality artificially." (Chalmers 2017) One example of this is the use of anthropomorphized characters and asking a viewer-player to embody the Mother Hen or Mother Bear character in the game. While playing as an animal character, the player still draws upon their human-sized sense of space and movement.

When a viewer-player is immersed in the role of Mother Hen or Mother Bear, they can have the experience of wanting their side to "win" (which inflicts violence against the other protagonist). They can then switch roles and play as the other character, viewing the story of survival and desperation from the opposite side. Chris Milk talks about the potential for VR to create empathy when he says, "VR represents a technology communicating to us using the same language in which our consciousness experiences the world around us: the language of human experience." (Milk 2016) While *Mother Bear Mother Hen* uses anthropomorphized characters to represent the human, it aims for the viewer to embody these characters and see the story through their eyes. Seeing and using one's disembodied animal hands in first person VR gameplay, while also wearing a jacket that represents that animal, the viewer-player is placed in a state of mind in which they can be empathetic of the character they are playing. After playing through the game as both Mother Bear and Mother Hen or watching someone else experience the game as these characters, a viewer can contemplate their role(s) in the game, the cartoonish violence they perpetrated or experienced, and how this relates to everyday life for themselves or for caregivers in society.

3. *Rattlin' Bog*

3.1 The finished artwork

Rattlin' Bog[4] is an interactive installation that uses digital fabrication, conductive surfaces, and the IF Magic microcontroller to engage a viewer in an animated onscreen bog ecosystem. It is displayed as a single-channel projection with an adjacent interactive wall sculpture (Fig. 6).

4. Link to project website: https://blurringartandlife.com/vb/rattlinbog.html

Fig. 6 *Rattlin' Bog* installation and link to demo video: https://youtu.be/pz65jtaPLEc

The viewer-participant controls the temperament and behavior of the animals onscreen by fitting the muskrat, snake, and eagle into magnetic conductive cut-outs on the sculptural device. When this triad is in place, it triggers the water in the bog to rise, the vegetation to bloom, and the snake and eagle to calm (Fig. 7). The squirrel chitters and flits between the snake and eagle on the tree. When the animal puzzle pieces on the device are removed and the water is low, the snake and eagle onscreen appear to be more agitated. A button on the sculptural device changes the virtual camera to display the animals and scene from different views. Beneath the tree is the muskrat character, a metaphor for the everyman.[5] The muskrat constantly strives whether the water is high or low (Fig. 8).

In climate change's proliferating wake, we experience the destruction that water brings when there is more than the ground can handle. Too little water also causes harm– without enough to sustain life, water's absence leaves landscapes to shrivel and burn. Like the *Rattlin' Bog* folk song[6], the animals here appear caught in a repetitive chorus, affected by the state of the ecosystem around them.

Fig. 7 *Rattlin' Bog* tree and landscape with snake in a calm state and squirrel with acorn on the trunk. The bog is filled with water.

5. The everyman is a character type that represents the common person.

6. *Rattlin' Bog* is a cumulative, repetitive Irish folk song.

Fig. 8 The busy muskrat in the onscreen animation with the water level low.

3.2 The production process

The onscreen content for *Rattlin' Bog* was produced first, with the scene and environment design being modeled by the lead artist in Unreal and then the character design, modeling, rigging, and animation being undertaken by team member Clara Tracey. Next, the animations, scene, and soundscape were combined with Blueprint programming in the Unreal game engine by team member Sarah Hendricks. The program was designed for the animals to coexist in the bog ecosystem and for them to move in a looping fashion with some randomness. Physical computing inputs were added to the Blueprints to cause the water in the bog to raise and lower and to allow the camera view of the scene to change to show different angles and compositions (Fig. 7 and 8).

The sound design for *Rattlin' Bog* is by composer David Freund (Fig. 9, L). The rattlesnake sounds were recorded at the North Carolina Zoo in May 2022. Dustin Smith, Curator of Reptiles, Amphibians, Fish, and Invertebrates, invited the lead artist and sound designer to record the zoo's rattlesnake, an event which also served as a training session for a new snake handler. All of the other sounds in *Rattlin' Bog* were recorded live in the mountains of Western North Carolina (Fig. 9, M-R).

Fig. 9 David Freund [L], *Rattlin' Bog* Sound Designer and Composer behind the rattlesnake enclosure at the NC Zoo. [M-R] Freund's microphones while field recording near Western North Carolina waterfalls and streams to capture audio for *Rattlin' Bog*, 2022.

To create the *Rattlin' Bog* physical computing device, the lead artist built a working wood prototype before designing and implementing the final version. The piece uses an IF Magic microcontroller from the Brooklyn-NY-based company, Indistinguishable From Magic (IF Magic, n.d.). The lead artist met the IF Magic developers at the IEEE-GEM conference at Yale University in 2019 when she exhibited her *Blue Boar VR* project. IF Magic aims to make physical computing inputs and outputs

straightforward to implement. An IF Magic shipment includes a device, a variety of interchangeable physical computing modules, and code that facilitates the process of connecting to Unreal and other game engines. The *Rattlin' Bog* team found the integration between Unreal and IF Magic to be smooth and troubleshooting time in the lab was reduced due to choosing this microcontroller for Unreal integration.

3.3 Critical Making and *Rattlin' Bog*

At a mid-stage in project production, *Rattlin' Bog* incorporated RSS feeds to bring news headlines into the Blueprints and print these on-screen as if the squirrel character were telling the snake and eagle the current news. Two news feeds were used, one from a conservative U.S. new source one from a moderate U.S. new source, to contrast the headlines and make the squirrel appear as a double-dealing informant in the bog ecosystem (Fig. 10). The project remained in this state with the RSS feeds from Spring 2022 through Autumn 2023 as the lead artist progressed the physical computing aspect of the project.

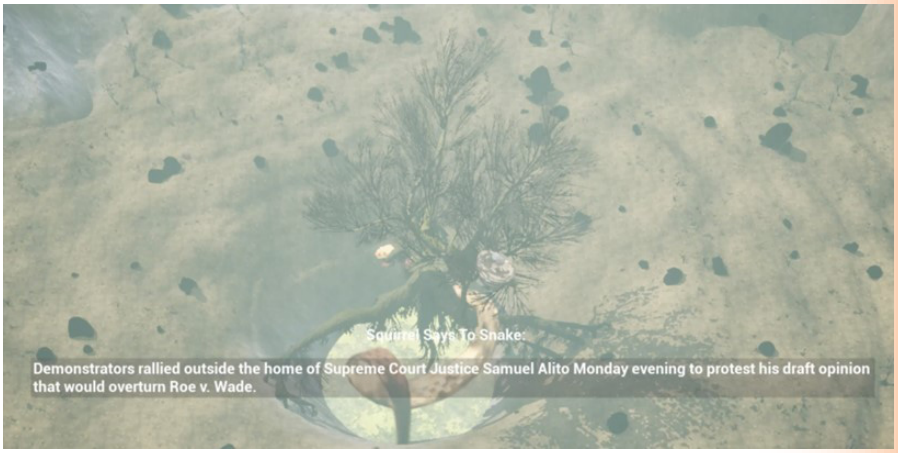

Fig. 10 Sample news headline from *Rattlin' Bog* mid-point version with RSS feeds printed to screen.

As news headlines continued to go from bad to worse, particularly in Autumn 2023, the artist no longer supported including them in the project. She removed the RSS feed link from the code and allowed the bog ecosystem to exist on its own alongside the physical computing device. This emphasized the environment, water, and animal aspects of the piece, as well as the aesthetics of the sculptural device and the onscreen content. Lucas Evers states that, “In Critical Making, there is no longer a divide between critical theory and artistic practice, but the practice itself is critical and philosophical.” (Evers 2017) The choice to add and later remove the headlines evolved from a critical making process and iterative testing of the onscreen content alongside the interactive device.

The process of creating the *Rattlin' Bog* physical computing device demonstrated radical experimentation with physical and digital materials. Screenshots of the tree were imported into Photoshop (Fig. 11) and edited to create a detailed background that was etched on a laser cutter. The wood was passed through the laser cutter to draw 11” wide sections over a 12-hour engraving session. The animal puzzle pieces were initially designed as vector graphics by team member Shiasia Beasley and then cut and etched on the laser cutter by the lead artist.

Building the device involved testing conductive materials, including graphite paint, wire, and copper sheeting, to allow the device to send a

signal to the IF Magic and the Blueprint programming code to make the onscreen water rise. In the final piece, hidden magnets sandwiched in the puzzle pieces hold the animals in place on the backing board. When all of the pieces are in place, the conductive paint on the back of the animal pieces connects with copper sheeting on the etched device to pass a positive electronic signal through the microcontroller to the running game.

The *Rattlin' Bog* interface intends to be straightforward to navigate while aesthetically compelling and visually complex. The interactive component of the device was designed with simplicity in mind. A 'toddler puzzle' modality was used to design large, easy-to inset animal pieces. When a viewer sees the puzzle pieces and the cut-outs on the device, it is easy to guess how to interact – by inserting or removing the pieces. The button on the device looks like a conventional button and therefore encourages viewers to press it and experience the resulting camera movements.

Fig. 11 Photoshop and Illustrator were used to combine pieces of the tree from the onscreen content and create an etching that would be laser-engraved onto the wood in sections on the Glowforge laser cutter.

Fig. 12 The final *Rattlin' Bog* device created with laser etching, conductive materials and IF Magic microcontroller.

Rattlin' Bog was first exhibited at Black Mountain College Museum + Arts Center's {Re}HAPPENING 12 at Lake Eden in April 2024. This event-based setting made visitors relaxed and ready to engage with the project. In the {Re}HAPPENING iteration of the *Rattlin' Bog* installation, the artist observed visitors interacting with the piece and noticed that many enjoyed trying to figure out how to engage with the sculptural device. Visitors tried different combinations to see how interacting with the sculpture affected the onscreen content. Some visitors devised that the possibilities for interaction and onscreen change were more complex than they actually are. For example, some participants thought that if they removed a particular animal and then pressed the button that this would cause the onscreen virtual camera to move to that animal. Others concluded that as each of the three animal puzzle-pieces was removed, that the water would rise to that animal's level onscreen. In truth, however, the onscreen water movement is binary – it is either high or low. Many people found the screen-based content to be uncanny – not quite realistic with at times jerky movements and a dream-like patina to the lighting and water. Some visitors even spontaneously laughed at the content onscreen and seemed to find the muskrat character to be particularly humorous and relatable.

Garnet Hertz states in the introduction to his Zine series, *Critical Making*, "...doing something yourself [...] is a crash course in understanding how something actually works [...]. The process of being humiliated by things that you think are easy or mindless is a valuable experience..." (Hertz 2012). This sense of being flustered by materials was integral to the process of creating the *Rattlin' Bog* physical computing device (Fig. 12). It is the most complex laser etching that the lead artist has created to date. The incorporation and functionality of the puzzle-pieces, which include embedded magnets, involved trying and testing materials. Staining and glazing the device, both before and after laser etching, required the artist to draw upon experience with oil and acrylic painting. Using copper sheets and wire to create a circuit that was essentially one button press (inserting the puzzle pieces and having the water rise onscreen as a result) required knowledge of simple circuits and the properties of conductive materials[7]. To create the final input mechanism on the *Rattlin' Bog* device, a momentary switch was embedded to allow the visitor-participant to press and change the camera views onscreen. Through two straightforward input methods (the puzzle pieces and button), the *Rattlin' Bog* viewer-participant can have an engaging interactive experience and sense that they are a part of the piece and the connected ecosystem.

4. Conclusions and Future Work

Call it Art Hacking, Critical Making, or making with a sense of play, creating *Mother Bear Mother Hen* and *Rattlin' Bog* applied processes combined through building, observing, and play testing, by the artist and her teams, over a three-year period. While the notion of an art hack may connote an organized event in which a group of collaborators create a digital artwork over a short specified period of time, this paper aims to expand the notion of art hacking to encompass modalities in which artists, as individuals or teams, use technological materials to create

7. These skills were practiced and honed when the artist co-taught *The Glass Electric* class at Pilchuck Glass School with Mark Hursty in 2019. This class examined various ways to create conductive circuits that connected glass materials with code and onscreen digital content (Bradbury and Hursty 2019).

artworks through a trial and error process that includes making with digital and physical materials.

Both projects discussed in this paper use Unreal as the game engine with which to compile the assets and link the physical computing components. The Arduino Uno-style microcontroller used in *Mother Bear Mother Hen* allowed for a variety of inputs and outputs, including light, sound, and movement, to be connected to the VR game through serial communication. Using the IF Magic microcontroller for *Rattlin' Bog* allowed for a more seamless integration between the game engine and the sculptural component because the company distributed the Blueprints necessary to begin working with serial communication to and from Unreal. This allowed the artist and team to focus on the aesthetic, conceptual, and technical concerns inherent to creating the device prototype and the final laser engraved interactive piece.

The lead artist and her team used play as a method for making and testing the components throughout the production processes of *Mother Bear Mother Hen* and *Rattlin' Bog*. Play is also evident in the engagement of viewer-participants with the final works. This was observed as audiences gathered around the players in the bear and chicken jackets when *Mother Bear Mother Hen* was installed in the *Future Bodies Symposium Exhibition* and in the exhibition of the *Rattlin' Bog* device at the {Re} HAPPENING, where visitors tried different combinations of interacting with the button and animal cut-outs while they observed the changes onscreen. Future projects from the artist and her team will be available on her website.[8]

8. www.victoriabradbury.com

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Research Assistants (*Mother Bear Mother Hen*): Concept Development: Lead Artist, Clara Tracey; 3D Modeling and Rigging: Clara Tracey, Keithon Turner; Game Development: Thomas Townsend; Music Composition and Sound Design: David Freund; Web and Social Media: Kayla Hammonds, Keithon Turner; Voice Acting: Joshua Lassiter (Narrator), Xavier Hursty (Baby Bears); Physical Computing and Jacket Construction: Lead Artist; Arduino-Unreal Integration: Nolan Scobie.

Research Assistants (*Rattlin' Bog*): Concept Development: Lead Artist, Clara Tracey; 3D Modeling and Rigging: Clara Tracey; Game Development: Sarah Hendricks; Sound Design and Composition: David Freund; Web and Social Media: Kayla Hammonds; Physical Computing and Digital Fabrication: Victoria Bradbury; Digital Fabrication Design Assistance: Shiasia Beasley; Rattlin' Bog uses an IF MAGIC microcontroller.

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My Robot Body: A Workshop to Promote Body Awareness and Digital Literacy through Embodiment with Robots

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We present *My Robot Body*, a workshop exploring the relationship between human bodies and non-anthropomorphic robots to foster personal body awareness and interpersonal communication. Drawing from embodied cognition and theatrical techniques, the workshop integrates advanced technology with dance and theatre methods. Using wearable control devices, participants animate five non-humanoid robots featuring different expressive characteristics, integrated in a system that allows for flexible reconfiguration at runtime to promote experimentation and creativity. The workshop aims to transcend social barriers through body-based interaction and foster digital literacy by providing hands-on experience with robotics technology. Participants reported increased body awareness and a shift in perspective on technology. Despite challenges such as disconnection between controller actions and robot movements, the workshop received high satisfaction and was viewed as an effective learning tool. Led by a multidisciplinary team, *My Robot Body* highlights the potential of stage performance for human-robot interaction research.

1. Introduction

Research on embodied cognition and the Proteus effect (Banakou, Groten and Slater 2013; Kilteni, Bergstrom, and Slater 2013; Lugrin et al. 2016; Peck et al. 2013) assigns to the body a central role in the way we process and understand reality. Thus, investigating the potential to radically alter our bodies supports the exploration of the possibility to go beyond the current understanding of our cognition. Recent research is addressing the topic of embodying non-anthropomorphic avatars (Dörrenbächer, Löffler, and Hassenzahl 2020; Espositi and Bonarini 2023; Krekhov, Cmentowski, and Krüger 2019). Can we seamlessly enter bodies that are non-humanoid? What kind of change may such transformation mean for the perception of oneself (Karpashevich et al. 2018; Otterbein et al. 2022)?

To explore this relationship, we propose *My Robot Body*, a format for a workshop at the intersection between physical theatre and robotics. This has been implemented with five different social robots, non-anthropomorphic in shape and expressive in their movements. They are the “bodies” that the performers participating in the workshop should learn to animate, with their own bodies, to implement an integrated theatrical performance. Several wearable sensors can be attached to different parts of the body, and, through an app, it is possible to quickly configure which sensor controls which movement of a robot. This flexibility grants the participants total freedom of experimentation and creation.

Keywords Avatar, Robot, Embodiment, Human-Robot Performance, Workshop.
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The core idea of the workshop is to use a robotic control system to foster personal body awareness and interpersonal communication "without limits", investigating the possibility of interaction by removing factors of bias (Shamay-Tsoory et al. 2013; Lishner et al. 2008; Vanman 2016) and exploiting only minimal and essential features (Espositi and Bonarini 2023). Technology acts as a filter, allowing participants to create a common language that transcends social barriers through their bodies (Cuan 2021). The workshop structure draws heavily on techniques from physical theatre and improvisation, enabling participants to harness their own creativity and imaginaries (Jochum and Derks 2019; Murphy et al. 2011).

Through the complex machinery of this framework, where the robot actions seem to be the focus, participants are invited to discover their own bodies to infuse life into the robots (Jochum and Putnam 2017a), fostering self-exploration and body awareness (Fdili Alaoui 2019). The control devices capture movement, distance and sound signals; thus, the participants should find creative ways to "use themselves" to generate meaningful activity in the robots (Won et al. 2015; Zhou et al. 2021). Participants can see the effect of their own signals on the robots and modulate it accordingly (Cuan 2021). Moreover, since the interaction in this setting relies on non-verbal communication, the workshop aimed at stimulating the participants to create their own physical language to communicate with each other though the filter of the robots (Dörrenbächer, Löffler, and Hassenzahl 2020; Laroche et al. 2021), thus overcoming background and nationality biases.

Moreover, with *My Robot Body* we also wanted to develop a tool to promote digital literacy, fostering interaction between the public and new technologies (Das et al. 2018). The robotic control system of the workshop gives the participants a physical, experience-based opportunity to understand the mechanism of its technological components, software, sensors, and motors, in terms of names, functioning, strengths and limitations, addressing the gap between public perception and the robotics reality. Given the growing interest in human-centred factors in robotics research (such as aesthetics, culture and perception), we believe this is an important area for education and research (Jochum and Putnam 2015).

We believe that stage performance can be a promising testing setting for many hypotheses in human-robot interaction (Jochum, Borggreen, and Murphey 2014; Jochum and Derks 2019); it is a relatively constrained yet rich environment where a robotic agent shares its actions with a human partner (Hoffman, Kubat, and Breazeal 2008).

The workshop was led by a multidisciplinary team composed of engineers and a professional dancer. A research team and Computer Science students developed the technological system.

The presented framework encourages audience participation, thus allowing the participants not only to learn by observing, listening, and building, but also to express themselves in this novel manned-unmanned teaming structure to share their ideas, queries, and accomplishments (Cubero et al. 2021; Das et al. 2018). The personalized and participatory nature of the workshop encourages to get actively engaged.

2. Background

In this section, we report previous works about human-machine hybridization, focusing on applications in performing arts.

A lot of work has been done on the exploration of embodiment of avatars, mostly in virtual reality or videogame settings, investigating questions about the amount of human similarity needed to support embodiment (Argelaguet et al. 2016; Hosa et al. 2019; Kao 2019; Kilteni, Groten, and Slater 2012; Krekhov et al. 2019; Latoschik et al. 2017; Tekgün et al. 2022). Research on homuncular flexibility has shown the capacity of human bodies to re-adapt and control structures with different morphologies (Molnar and Menguc 2022; Steptoe et al. 2013; Won et al. 2015; Won, Bailenson, and Lanier 2016).

In performing arts, the avatar is often physical, a robot, operating in a physical environment where information can be obtained via our senses (Chen et al. 2011). If these avatars are paired with systems that act directly on the human body, the experience becomes fully centered on physicality. In this context, the stage environment can be controlled (Murphy et al. 2011) and offers a scaffolding for the creatures, since spectators are ready to suspend their disbelief (Jochum, Borggreen, and Murphey 2014). Moreover, artists are trained to look for creative solutions by exploring ambiguity and uncertainty, working at the boundaries of a given technology, transforming design and technological constraints into advantages (Jochum, Millar, and Nuñez 2017b).

Hybridisations with the machine differ in the amount of direct control that the human performer can exert, ranging from only being able to influence a pre-defined behaviour or algorithm, in what we can call "interactive", to total control of the machine, i.e., "puppeteering".

2.1 Interactive Systems

In interactive systems the human action influences pre-programmed behaviours of the robot agents.

The seminal work of (Pinhanez and Bobick 2002) introduced an artificial character that dynamically adjusts its behaviour based on spectators' and actor's actions. Performance details like intensity, gestures, pauses, and audience interaction change according to other actors' performance and audience reactions.

"The Dynamic Still" (Jochum and Derks 2019) explores improvisation and choreography between humans and robots, aiming to develop real-time interactions and motion algorithms for human-robot engagement. It focuses on mapping motion algorithms to a wheeled cart-like robot based on human dancer movement patterns, emphasizing spatial awareness and orientation over representational gestures.

"Mimus" (Gannon 2017) is an installation featuring an industrial robot equipped with eight ceiling-mounted depth sensors. These sensors track viewers' movements and analyse attributes such as age and engagement level. Based on this data and a programmed set of animal-like behaviours, the robot interacts with the "most interesting persons" by approaching them. This creates a closed affect loop where the robot's actions influence the viewers' reactions, and vice versa.

In (Hoffman, Kubat, and Breazeal 2008), a robotic puppeteering system is developed and employed in a theatrical production involving one robot and two human performers. The system's interface combines

reactive gestures and parametric behaviours, enabling the puppeteer to control pre-programmed motions of the robot. The aim is to allow a single operator to control the robot's behaviours while transitioning to autonomous subsystems. Despite physical distance, the operator feels the need to synchronize actions with the robot, as though he was interacting with humans.

2.2 Total Control: Puppeteering

In puppeteering human operators fully control the avatar.

In (Jochum, Borggreen, and Murphey 2014), robotic marionettes are featured in live performances. Motion capture technology is utilized to animate the robots indirectly, by capturing string configurations to move the marionettes. Puppeteers must compromise with the physical dynamics of the puppets, as these resist direct manipulation, to create believable and expressive characters during the performance.

In (Murphy et al. 2011), the robot puppets were seven radio-operated aerial vehicles which, despite their limited degrees of freedom, demonstrated expressiveness, enhancing the emotional impact of the play.

"Piano&Dancer" (Palacio and Bisig 2017) featured a dancer controlling an electromechanical piano through physical movement.

In "OUTPUT" (Cuan 2021), an industrial robot serves as a dancing body, allowing a human to dance alongside it. The artist mapped the robot's joints onto her limbs or entire body, creating a human dance sequence inspired by physical labour. This sequence was performed by both the artist and the robot, in an interactive feedback loop where the artist modified her choreography based on the robot's movements. The artist experienced a sense of being "inside the machine," feeling as if her body had extended into the robotic device.

The authors of (Jochum, Millar, and Nuñez 2017b) explore creative strategies for robot design and control in live performances: soft design, voodoo control, and hybrid control. Inspired by traditional puppetry, these aim to create expressive, fluid movements for large-scale robots closely interacting with humans. The focus is on expressive movement more than on functionality, leading to innovative design and control solutions with potential applications beyond entertainment in human-in-the-loop systems prioritizing expressiveness and intuitive interfaces.

In (Espositi and Bonarini 2023), an interactive installation linked participants' bodies to sensorized dog leashes, serving as controllers for a robot puppet in real-time. The controller space was separate from the robot's space, with participants unaware of the connection. This passive link enhanced immersion and transmitted nuanced qualities to the robot, resembling a living being. The localized action of the multiple controllers altered proprioception, fostering a sense of body rediscovery for participants.

Finally, technology can be used to act directly onto the body to actively modify its perception (Espositi and Bonarini 2023). In (Jochum et al. 2018), exoskeletons merge human and robot motions, while (Karpashevich et al. 2018) explores active costumes altering dancer experiences. These designs inspire novel movements, fostering new aesthetics and character embodiments. In (Otterbein et al. 2022), wearable technology's impact on movement and self-perception is explored through artistic methods, showing how wearables can influence movement even without auditory or visual feedback. (Gemeinboeck and Saunders 2017)

use choreographer insights to design non-anthropomorphic robots, employing a wearable "costume" or "prosthesis" to extend a dancer's body and explore machine embodiment. Like our own aim, the authors wanted the dancer not to just unilaterally control the movement of the object but rather to develop movement with it.

3. The System

In this section, we describe the technical system that we implemented to support the workshop. It is made of three interconnected components:

- The robots, the non-anthropomorphic bodies that the participants had to animate.
- The controllers, the wearable devices that the participants used to transform their actions into movements of the robots.
- The app, the central hub that makes it possible to reconfigure the control mapping at any time.

3.1 The Robots

The robots are the entities that the participants will embody, materializing actions induced by the control devices. Real robots provide the opportunity to create diverse body types and can be deployed in real-world settings to interact with physical environments, objects, and people, including theatrical stages (Henning and Lindelof 2020). These robots are not autonomous, but completely under the control of the participants, acting as avatars (Cuan 2021; Jochum, Borggreen, and Murphey 2014; Otterbein et al. 2022).

Robots are characterised by:

- their degrees of freedom (DoFs), determining the range and type of movements they can execute. Each DoF operates independently and is controlled by a distinct signal from a control device.
- their appearance: we emphasised novel and disruptive body structures rather than biomimicry. Robots may be stationary or mobile, with parts capable of movement and configuration changes, and their size influences their interaction capabilities.

The workshop utilised five robots to offer participants a diverse range of characteristics to experiment with. Key differences among the robots included their mobility (fixed vs. wheeled), the degrees of freedom number and type (mechanical movements, lights), which influenced controllability and the level of detail in actions, height (affecting impact on spectators), and materials/appearance, which influenced the robot's "character" and overall aesthetic and emotional effects of movements.

Siid, the flower robot

Siid (Fig. 1) is a flower-shaped robot with a total of 7 controllable degrees of freedom (DoFs). It can rototranslate using omni wheels (3 DoFs), and its petals can open and close (1 DoF). Additionally, it features an LED inside its bulb that can vary in intensity (1 DoF), and its digital eye's pupil can move along an eye-like screen (2 DoFs). It has a height of 70cm and is the most bio-inspired of the robots. The contrast between its rigid shell and soft head is underlined by the movement of the petals, which adds mystery and allows for significant changes in its appearance.

Fig. 1 The robot *Siid*. Controlled by a participant with motion of the wrist and head.

Odile, the “robot-like” robot

Odile (Fig. 2) is characterised by two mechanical arms of different lengths: a short one, serving as the head, capable of forward and backward movement and rotation of the tip in multiple directions, and a long one, functioning as the arm, capable of intricate movements, including articulated movement of the end-effector. Odile has 13 DoF, and did not move in space in this workshop; its appearance is explicitly robotic, a baseline for robot aesthetics.

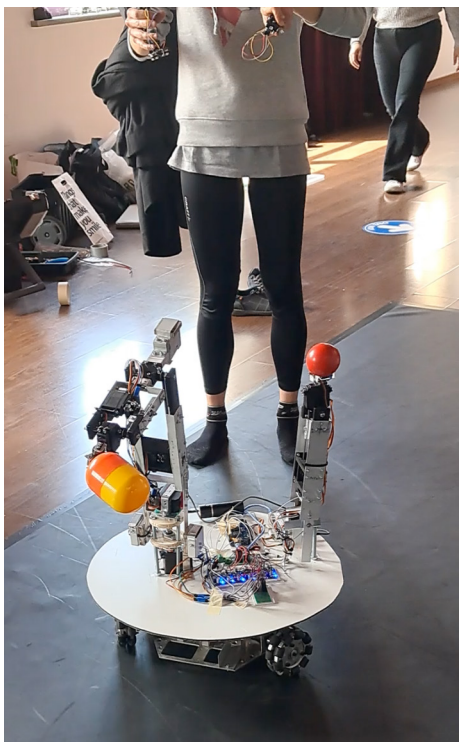

Fig. 2 The robot *Odile*. Controlled by a participant with distance.

Blackwing, the winged robot

Blackwing (Fig. 3) is equipped with omni wheels for rototranslation (3 DoFs) and a servo motor that controls two long thin poles, extending or contracting elastic fabric between them to create wing-like movements. An additional servo enhances the expressivity of the fabric by adjusting the frontal movement of the pelvis, effectively turning it into a sail, totaling 5 DoFs. Its aesthetic is characterized by black fabric covering its body, lacking an explicit face, thus maintaining a neutral appearance that directs focus towards its movement.

Fig. 3 The robot *Blackwing*. Controlled by a participant with sound and motion of the head and wrist.

Scarecrow, the plastic dancer

Scarecrow (Fig. 4) is a robot designed to experiment with the expressivity of plastic sheets. It consists of a tall wooden cross structure mounted on an omni-wheel base that can rototranslate (3 DoF). The wooden structure, over 1.70 meters tall, is covered with thin plastic sheets with long hanging parts. Scarecrow's expressivity comes from the interaction between air and the sheets, resulting in a slow and soft, ghost-like floating motion that can be controlled by the movement of the base. With only 3 DoF in the base, Scarecrow is the least actuated and tallest of the robots.

Fig. 4 The robot *Scarecrow*. Controlled by a participant with sound.

Sonoma, the wooden dancer

Sonoma (Fig. 5) is a robot with 6 degrees of freedom (DoFs), 3 DoFs on omni-wheels and a 3-DoF arm that resembles a sickle, beak, or claw. It features a large gown on its lower body, which accentuates its rototranslational movement and responds dynamically to it. Sonoma stands at a total height of 120cm, making it the second tallest robot. Its arm can extend outward by over 1.5 meters, allowing for highly noticeable and unexpected expressive behaviours. Sonoma combines a human-recalling element, the gown, with an abstract wooden arm, creating a disruptive blend that encourages exploration and expression.

Fig. 5 The Robot *Sonoma*. In the foreground, in the company of the other robots.

3.2 Control Devices

A control device enables a mapping between the participant's and robot's movements, gathering data from sensors and transmitting them to the robots.

In the design of the control system, we followed these guidelines:

- Engaging Control Mapping, to encourage novel use of body DoFs, such as utilizing unconventional postures (Steptoe et al. 2013; Krekhov et al. 2019) or remapping existing ones (Won et al. 2015).
- Flexible Remapping, allowing for control adjustments to accommodate user preferences, with some favouring natural mappings while others proposing challenging, more immersive ones (Steptoe et al. 2013; Won et al. 2015).

We designed three types of control devices, each associated with a specific sensor: accelerometer, sonar, and microphone. Multiple copies of each type were produced, totalling 22 devices, to enable parallel experimentation by participants (Fig. 6).

Each device operates independently with its own power source, and includes the sensor, an ESP32 module with an integrated battery case for power, control logic and WI-FI, and a 3D printed case with interfaces for velcro straps for easy wearability on any body part. Each device measures 3x3x15 cm in size.

Fig. 6 The ***Control devices***. From left to right: accelerometer, sonar and microphone types.

The three types of devices are described in the following.

Accelerometer

The accelerometer device uses an MPU6050 accelerometer sensor to capture angular data. Upon activation, it establishes a reference frame based on the initial position and produces angular displacement along three axes. This enables the device to capture three independent control signals, each symmetrical around the "zero" position, spanning from "-max_absolute_value" to "max_absolute_value" on each axis. The max absolute value can be adjusted in real-time to alter the granularity of the sensor signal and the range required to cover the full movement of the corresponding degree of freedom.

Sonar

This device utilises a sonar sensor to capture distance data. It measures distances from 0 (minimum or invalid reading) to a maximum value, which can be adjusted in real-time. The device offers flexibility as distance can be manipulated in various ways: it can measure distances between participant's body parts or with respect to external objects such as walls or the floor, and even other participants that can interact by acting as obstacles for each other, altering their relative positions in space.

Microphone

The Microphone device features a microphone that collects sound intensity. It has a high threshold to filter out background noise and only capture voices very close to the sensor. The data range spans from 0 (sound below threshold) to "max_intensity", which can be adjusted in real-time. The objective is to enable participants to explore radical transformations between sound and movement, where their voices directly control robotic movements. This encourages the production of sounds solely by volume modulation, enabling yet a different layer of body awareness.

3.3 The App

The most crucial aspect of the entire system is the possibility to reconfigure the control mapping easily and at runtime, to foster experimentation and to make the system as natural to use as possible, reducing the gap between the participants and the technological aspects. To do this, we created an app that communicates with the robots and the devices at runtime. Its purpose is to enable the dynamic reconfiguration of connections between robot degrees of freedom (DoFs) and specific signals from the control devices.

The app was always operated by facilitators, and participants could ask at any time to reassign connections between a control device and a specific robot DoF, which was done using the app interface.

The app uses a configuration file to connect the characteristics of each robot's DoFs to the type and setting of sensors for each control device. It allows for the adjustment of sensitivity by modifying sensor ranges and thresholds. Additionally, the same control signal can be assigned to control multiple DoFs simultaneously, even across different robots. This flexibility allows for exploration of different effects of the same actions transformed into diverse robot movements.

4. The Workshop

This Section describes in detail how the workshop was structured.

Facilitated by an engineer with a theatre and dance background and a professional dancer, it spanned one day from 10 am to 6 pm with a lunch break. It took place in a theatre with professional dance floors.

The structure included an icebreaker, reflection on participants' initial imaginaries, warmup focusing on dance and body awareness,

introduction to technology, guided and autonomous experimentation, creation of performances, and concluding reflections and farewells.

Each section is introduced here below, addressing its aims and relevance for the workshop.

4.1 Icebreaker: why you are here

The session began with an icebreaker activity where participants introduced themselves, their backgrounds, and their interests related to the workshop topics. Participants came from diverse backgrounds including scenography, performative arts, engineering, and dance. Their common interest lay in experiencing new technologies firsthand, particularly those that are intriguing but often inaccessible to non-technical environments due to the lack of available contexts and systems.

4.2 Reflection: your imaginaries

The diverse participant backgrounds, with varying levels of exposure to technology and robotics, brought great richness to the workshop. To tap into their unfiltered imaginations, participants were initially asked to express their perceptions of these technologies through words, sentences, or images without prior exposure to the robots and control devices. This exercise aimed to spark reflection while crystallising the initial preconceptions that we aimed to modify throughout the workshop. The papers containing their expressions were collected and set aside for later use.

4.3 Warmup: dance and body awareness

This last session before the introduction of the technology aimed to activate participants' bodies before interacting with the machines, achieving two objectives: establishing the workshop space as one where the body is used differently and fostering positive group dynamics free from mental constraints. Participants engaged in a brief stretching phase followed by a dancing game where they moved freely in the centre of a circle while others imitated them. The increased body temperature prepared them for smaller group activities, where one participant at a time moved freely while others acted as soft, viscous resistances, enhancing perception of even the smallest movement details.

4.4 Discovering the Technology: the first steps

Participants were now introduced to the robots and devices. The main objective was to explain the system comprehensively, covering robot movements, device sensors, and app functionalities. To manage the high amount of information, this phase was structured to be practical. Participants were asked to volunteer one at a time and directly try the control devices on different robots, as the facilitators explained device functions and robot movements and demonstrated how control devices could be worn on the body (Fig. 7). Computer engineering students continually reconfigured control mappings using the app to demonstrate how a single control device could span all robot degrees of freedom.

Fig. 7 First contact with technology. Hands on introduction to the control devices, app functioning, and robot motions.

4.5 First Experimentation: guided

Participants were divided into small groups and assigned to specific robots. Each group was given a simple task, such as moving the robot from point A to point B. Participants had the freedom to choose control devices and mappings to achieve the objectives. Facilitators moved between groups to provide guidance, stimulate creativity, and encourage different approaches. Participants were encouraged to start with fewer controllers and gradually increase them over time (Otterbein et al. 2022). After 30 minutes, groups shifted to a different robot for a total of two rounds, allowing all participants to familiarize themselves with all three types of control devices.

4.6 Reflection: expressive potential of everyday objects

After the lunch break, a second reflective moment was introduced to leverage the change in pace. Participants formed a circle as facilitators passed around everyday objects such as tape, a wheel, a piece of paper, a pen, and a broken mechanism. Each participant shared their thoughts and imaginations about how these objects could come alive, drawing from personal experiences or improvising on the spot. Afterwards, participants examined the robots closely, considering materials, shapes, and sharing initial impressions or reflections with the group. This activity aimed to stimulate participants' imaginations and encourage them to exchange ideas, preparing them for subsequent phases where they were more autonomous in creating narratives.

4.7 Second Experimentation: autonomy

This phase was similar to the first experimentation of Section 4.5, but participants were now given significantly more freedom. No specific groups or tasks were enforced, and participants were not required to focus on any particular robot. Instead, they were encouraged to freely experiment either individually or in groups with any aspect they found interesting (Fig. 8). Facilitators supported participants' creative choices by suggesting different approaches, providing ideas to those in doubt,

and encouraging changes when participants remained stuck on specific configurations. The goal was to ensure that by the end of this phase, all participants had experimented with all robots and devices at least once.

Fig. 8 Free experimentation: autonomously exploring the possibilities of the robots' and one's own bodies.

4.8 The Final Presentations: creating the performances

Participants transitioned from guided (Section 4.5) through autonomous exploration (Section 4.7) into the final stage. They were tasked with creating their own performance using the devices and robots in any way they preferred. Participants gathered in a circle, and the papers they had written or drawn earlier (Section 4.2) were collected, grouped by theme, and placed on the floor. After reading them, participants stood next to the group that resonated with them the most, forming two groups. Each group was then given 40 minutes to create a scene, lasting no more than 3 minutes each, using the chosen papers as title and themes. Participants could incorporate music, and facilitators supported them throughout the creative process. Finally, both groups presented their scenes to the others (Fig. 9; Fig. 10).

Fig. 9 Final scene: *"In Sync"*. Collaboratively controlling *Blackwing* with *motion*.

Fig. 10 Final scene: *"Elastic"*. Competing to control *Scarecrow* with *distance*.

4.9 Reflection: Discussion and farewells

The workshop concluded with a final reflection session. Participants gathered in a circle, and the papers created earlier were returned to their respective authors. Everyone shared their impressions, emotions, and how their initial expectations compared to their actual experience. Finally, the facilitators invited the participants to share ideas for improvements for future developments.

5. Discussion

The activity involved two groups of participants. The first group consisted of Computer Science students who worked alongside the research team on the software and control devices for the robotic system over a 3-month period as part of a university project. After the development phase, they served as supporting facilitators during the workshop, gaining insights into the system's strengths and limitations and finding solutions to arising issues. Their role as facilitators also provided them with exposure to a different context from their usual environment and allowed them to interact directly with the participants. The second is the group of the participants, with diverse backgrounds and ages, including dancers, performers, engineers, actors, arts and scenography students, a choreographer, and an acrobat, aged between 22 and 45, hailing from Italy, Serbia, and Russia.

Initially, participants preferred the microphone sensor due to its ease of use and intuitive nature, enjoying the seamless translation of sound modulation into movement. However, as the workshop progressed, the accelerometer and sonar became more prominent despite being initially challenging to master. These sensors encouraged diverse body movements and interactions, unlike the microphone, which limited movements due to its need to be kept close to the sound emitter. Participants rarely utilized all three angles of the accelerometer simultaneously due to sensitivity issues, preferring to distribute multiple accelerometer devices across the body. Sonar received the most positive feedback overall, combining the simplicity of the microphone with the body involvement of the accelerometer and offering diverse creative solutions. Participants demonstrated high levels of experimentation, using various elements such as each other, space, and the robots themselves to transform data into robot movement. They also explored un-

conventional uses of control devices, such as attaching them to sticks or wheels, leaving them in specific positions in space, or combining them to form complex devices.

When controlling robots in groups, two main approaches emerged: collaboration, where participants coordinated to create cohesive movements, and playful competition, where they intentionally generated incoherent movements for the robot. Except few moments of extreme experimentation, participants generally preferred using no more than two devices simultaneously. Concentration was required to use and monitor device effects on the robots, and this made handling more than two devices at once challenging. Instead, participants preferred using the same devices across multiple robots to control more degrees of freedom simultaneously, indicating that it was easier to focus on device usage and monitor their effects on the robots rather than on themselves.

As the workshop progressed, participants preferred robots with fewer degrees of freedom (DoFs) for easier coordination and clearer actions. Odile, with its 13 DoFs and inability to move in space due to technical issues, was quickly abandoned due to complexity and coordination challenges. Siid and Sonoma, despite their richness, were appreciated, but participants focused on a subset of their DoFs. Interaction and coordination were highest with these robots, requiring small groups to leverage their expressive potential. Focus shifted to Scarecrow and Blackwing, which could be controlled expressively with one or two devices, allowing participants to manage choreographies alone. Scarecrow, especially, was preferred for free experimentation, with participants using the microphone to control its floating movement. Consequently, these robots were chosen for the final performances.

These findings suggest that the more complex robots are very relevant to foster creativity and experimentation, but to properly leverage them it would be necessary to rethink our system based on independent control of each DoF, which is feasible for very simple structures, while more complex ones, like the 6DoF arm of Odile, could be more naturally controlled by acting directly on the end-effector, rather than on all the joints independently.

Participants observed a discrepancy between their actions and the corresponding robot movements, particularly when controlling robots with slower dynamics. For instance, controlling Sonoma's wooden arm's lateral movement with an accelerometer placed on a participant's hand resulted in challenges due to the different speeds of human and robot actions. While participants could cover the accelerometer's signal span quickly, the corresponding movement on Sonoma's arm was slower due to its weight and size. This often led to playful attempts to move faster than the robot, but the experimentation proved less interesting than the opposite, when the participants adjusted their bodies to match the robot's dynamics. A future direction may be to add mechanisms that act directly on the participant's body, to force them to follow the dynamics of the movements that are mapped, as in (Dörrenbächer, Löffler, and Hassenzahl 2020; Espositi and Bonarini 2023). Moreover, in the absence of such a feedback system, it is difficult for the participants to really understand the effort that the robot's movements require. This led to the robot Sonoma breaking, after being overworked as mentioned before.

The workshop initially aimed to enhance body awareness by allowing users to transform their movements into actions of different bodies using novel technologies. Interestingly, a significant additional finding

was that the workshop effectively promoted digital literacy. Participants gained hands-on experience using sensors with their bodies, understanding their potentials and limitations, and witnessing data transformation into mechanical actuation. The seamless reconfigurability of the technology facilitated experimentation with various configurations, masking complexity. Participants unanimously recognized this as a relevant takeaway, suggesting the workshop's potential as a learning tool.

Participants found the workshop to be both instructive and enjoyable, leading to a shift in their perspectives regarding the devices and their potential impact and use in innovative performances. They suggested that a two-day intensive workshop would be optimal given the novelty and density of the topics. Additionally, they emphasized the need for more intuitive controls for complex robots and mechanisms to enhance the sense of connection between participants and the robots they control.

6. Conclusions

We developed the blueprint of a workshop based on immersive control of non-anthropomorphic robotic bodies.

The workshop combines advanced technology with dance and theatre methods to offer a comprehensive experience. It includes five distinct social robots with diverse characteristics and capabilities, along with three types of wearable control devices corresponding to different sensors (accelerometer, sonar, microphone). Additionally, an accompanying app enables real-time adjustment of mappings between robots and controllers, enhancing flexibility and adaptability during the workshop.

The *My Robot Body* workshop spanned one intensive day and was conducted twice for a total of 11 participants in a theatrical setting. It integrated techniques from creativity, dance, and theatre to encourage participants to explore their imagination and engage with their bodies in a new way. The technological system, including various robotic bodies and control devices, was well-received, stimulating participant interest and facilitating experimentation, even beyond the initially envisioned possibilities.

As participants became more skilled with the controllers and sought to create coherent movements in the robots, they shifted their preference towards less complex robots that could be fully controlled by a single person. Similarly, participants typically used no more than two controllers simultaneously due to the high coordination required to use them precisely.

Participants identified a limitation in the system regarding the "distance" between controller actions and the corresponding robot movements, which led to a sense of disconnection. The disparity in dynamics between the fast movements of participants and the slower movements of the robots occasionally resulted in playful behaviours, but ultimately created a disconnection. This mismatch in speed also caused strain on the robots, leading to one of them breaking due to being overloaded by participants unaware of the strain caused by certain movements.

Participants expressed a high level of satisfaction with the workshop, noting a shift in their perspective on new technologies and an increased level of body awareness. They reported experiencing an "out of body" sensation when focusing on controlling a robot for extended

periods, feeling their familiar body motions being translated into movements of a new body. Additionally, the workshop was seen as an effective learning tool for fostering digital literacy, as participants were able to directly engage with sensors and actuation, gaining first-hand experience of their potentials and limitations in a seamless context of physical experimentation.

6.1 Future Directions

Future instalments of the workshop will require two major improvements.

High-level control

Participants in the workshop preferred simpler robots as they were easier to control by acting on each independent joint or minimal unit of movement. This method of control was more compatible with rototranslation speeds and movements requiring the action of a single actuator, such as opening and closing motions of petals or wings. In future versions, complex types of motions like the end effector of a flexible arm should be aggregated to create more intuitive DoFs.

Connect the participant's and the robot's motions

Currently, any control device can be linked to any type of motion of any robot, regardless of the motion's type and dynamics. This sometimes creates a disconnection between the participants and the robots. Participants may not realize the required dynamics of the robot's movements, leading to frustration or playful challenges that could result in damage. In the future, integrating control devices with active feedback systems will provide sensations or restrain participant movements based on the controlled DoFs, enhancing the connection between participants and robots.

Finally, following the suggestions of the participants, future versions will be structured to last longer, and to provide a wider range of control devices, while at the same time incorporating monitoring systems that capture the data on the participant's use of the devices to provide clear numerical data for analysis, as a measure for the results.

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Digital Performativity and its Slippage of Agency in Cyberspace

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This paper explores the intricate relationship between performance and identity formation, particularly in the context of digital environments. Through an exploration of various dialogues and spaces, it examines how identities are constructed, unfolded, and transformed through acts of performance. Furthermore, it introduces the concept of digital performativity and its automated manifestations within digital networks, challenging traditional notions of performance and identity in the digital age. Drawing from discourses of Surveillance Capitalism and object-oriented identity, the paper argues for the autonomy of digital performativity, shedding light on its unique characteristics and implications for identity construction in the cybernetic era.

1. Introduction

Performance has always been taken as an important approach to construct or deconstruct self-images: How does performance negotiate identities? In different dialogues and spaces, how do identities take shape, unfold, and transform through acts? From traditional performance in theatrical settings to the performative digital realities that we live in today, how has performance been altered and what new possibilities have emerged through the shift into digital lenses? In this essay, I introduce the notion of performativity in digital networks and propose that digital performativity has been automated. In chapter two, I discuss what is performance from theatrical to contemporary settings, and investigate the notion of body, shame and desire, and users in the context of self-exhibition and identity-making of performance. I also interrogate power/resistance dualism by introducing the concept of performativity. Then I transit my focus to digital performativity and its characteristics. In chapter three, I propose the autonomy of digital performativity through discourses of Surveillance Capitalism and object-oriented identity.

2. Performance and performativity: from physical to digital spaces and the gaze of the camera

2.1 Performance in theatre

Performance in traditional settings is conducted in pre-defined frameworks: it suggests an actor who consciously follows – or refuses to follow – a script. Individual is not free to choose an identity in the way they might select an outfit. Equally, the individual is not condemned to simply act out a structurally determined identity (McKinlay 2010, 233).

Keywords Digital Performativity, Agency, Identity, Digital Networking, Surveillance Capitalism.
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In *Performative Acts and Gender Constitution: An Essay in Phenomenology and Feminist Theory,* Judith Butler states that Identity is conceived as the "stylised repetition of acts through time, and not a seemingly seamless identity"(2016, 520). According to Erving Goffman in his The Presentation of Self in Everyday Life, the "front stage" that activates the script, is the setting where the performer is subject to judgment against generally accepted social norms, from an audience equates with "society." The "back stage" in contrast, is a safe environment where the performer can "relax, drop his front, forgo speaking his lines, and step out of character" (Goffman 1990, 70). Therefore, the script, can be deemed as an omnipresent circumscriber to the acts, bounding the body to its construct of predetermined identities.

But how do we perceive acts and make them into certain constructs of image? Speaking from the phenomenological perspective, acts are language, gesture, and all manner of symbolic social sign to build social reality through social agents (Butler 2016, 519), and as audiences, we go into theatres with expectations and institutionalised presumptions. Even if we don't have any knowledge or context about the performance, we are still introduced to the pre-established role-playings and our impression of these identities keeps being reinforced when the script is at play. Hence the body undertakes the pressure of performing in alignment with these impressions, and confirms the identity of the actor. There is nothing "low-maintenance" and "natural" about bodies. It undergoes the "forced reiteration of norms" to enact identities — a stylised entity to compose social, cultural, and historical construction in performance.

Goffman discusses that "people in the same social establishment are constantly engaged in the process of 'impression management,' wherein each tries to present themselves and behave in a way that will prevent the embarrassment of themselves or others"(Goffman 1990, 74). He keeps on explaining further that all parties in the interaction are working to achieve the same 'definition of the situation,' meaning that all understand what is meant to happen in that situation, what to expect from the others involved, and thus how they themselves should behave. Butler further addresses this impression management as a belief system — "that constituting acts not only as constituting the identity of the actor but as constituting that identity as a compelling illusion, an object of belief" (Butler 2016, 520). The performance essentially propagates a collective making of identities where the observers impel the actor to act in the avoidance of the feeling of shame, the shame of failing to achieve a prescribed impression, a shared belief.

Therefore, I argue that traditional performance is the construction and realisation of pre-contextualised beliefs empowered by social and cultural construct — the audience forges the gaze, whilst the actor materialises it into identities. The body is present but at the same time absent — the portrait of self in its bodily realities is hidden and irrelevant. The performance is fundamentally an operation of creating and consuming cultural products through its act.

2.2. Performance in art and improvisation

Transitioning from fully scripted performance pieces to improvisations and performance in art, what new epistemologies and ontologies of identity have emerged? How does artist destabilise the notion of fixed

identities and shift the power apparatus through the construct of self? With the aid of technology — camera and video camera, has the context of users changed?

> *Basically one wants to say something which cannot be said,*
> *so we make a poem where one can feel what I meant.*
>
> *(Birringer 1986, p.97)*

Art performance is a reclamation of agency, an empowerment of creating the bodily realities in the performers' own will, a break free from the "front stage" of the social norms. Artists constantly investigate and challenge the portrayal of self, and disturb the familiar relation of the physical body. It interrupts the social interaction and belief system in the settings of traditional theatrical performance, which also reflects on Derrida's theorisation of 'deconstruction', 'presence' and 'absence', identity 'formation' and 'deformation' (Derrida 1981).

Improvisation, as an essential artistic methodology, celebrates individual 'identities' rather than actualising subscribed collective beliefs. Improvisers use techniques and technologies to actively generate a conversation of control and freedom, from strictly scored works to semi-structured practices and free improvisations. It explores the relatedness and interaction of elements in a system, in Dancer Steve Paxton's words, it "nurtures movement and place and, patterns emerge to which an artist can respond." In improvisation, these patterns can be both expected and unexpected. The unpredictable and predictable tension in improvisation challenges the practice of the artist. We look to the artist's work, which we believe, "encompasses a holistic technicity, a process that combines the momentary, emergent quality of improvisational practices, techniques at the construct of being and the function of dynamic, interactive systems" (Broadhurst 2012, 21). We contend that such works are not found in predetermined or fully scripted pieces and that some artists have the intent of articulating and emulating emergent, complex systems in their practice.

Hence improvisation creates the momentary dialogues within its social environment, which upsets the 'impression management' system and new bodily realities emerge. Dancer Pina Bausch uses her choreography to continually frustrate audience expectations by fusing disparate elements, frequently incorporating new technological developments that are juxtaposed creating a distancing effect and causing the audience to actively participate in the activity of producing new meaning.

Broadhurst also states that "In many performances, there is a continual construction and deconstruction of identity together with the problematization of originary meaning." Referring to Dr Olu Taiwo's theory on 'being, becoming, and performance', where he argues that "becoming that results from feelings concerning wholeness and internal flourishing, which is a consequence of an active and constructive engagement with one's personal struggle; a struggle that attempts to reconcile the expressions of different conflicting internal voices; voices within a network of competing identities underpinning an individual" (Broadhurst 2012, 44).

Artist and photographer Cindy Sherman is well-known for her interrogation of the Instability, multiplicity, and complex nature of identities. In Sherman's Self-portraiture and Untitled Film Stills photogra-

phy series, she transformed herself into all different kinds of characters from either the mundane life or Hollywood Glamour, you can barely recognise herself through all the enactments of othered life. She performed for the camera in the role of a cinematic auteur — she set up the whole stage as well. The Writer Ingrid Sischy noted, "She's the director, the producer, the set designer, the costume mistress, and the star as well... In her hands, images aren't straitjackets but vehicles to show the infinite possibilities of who she could be" (O'Hagan 2019).

Fig.1. Cindy Sherman, *Doctor and nurse*, 1980.

By presenting herself in every single work of hers, but completely camouflaging till her image of self is obscured and transformed, is she unfolding the network of her layered, competing identities manifesting or is there a larger social context she is trying to confront through her role-plays? Critics have argued that her work is "a dark mirror to our era of self-obsession," it is driven by the pleasure of self-exhibition, and she staged a playground for her identity fantasies with the aid of technology. However, Cindy claimed the opposite: "People assume that a self-portrait is narcissistic and you're trying to reveal something about yourself; fantasies or autobiographical information. In fact none of my work is about me or my private life." Her life is nothing like the grotesque always depicted in her work, instead, she watches telly and stays in a lot, "I am terribly average, I buy my tits and asses from the same store as my noses. Now I think I have every kind of fake breast and backside available" (Rumbold 2017).

The fact that Sherman uses synthetic attachments to construct alternative body realities through her mundane life characters illustrates a resistance again the social normality of the body. Liz Parr addresses that "Synthetic or superficial interventions on the body are considered unnatural thus deceptive prosthetic, fake attachments of body, " thereby the alternative identities Sherman establishes through her photographic performance are registered as invalid and inauthentic entities in institutions.

Dean Spade talks about the neutrality of the body in "Dress to kill fight to win", he claims that "There is no such thing as an unmodified body — we come to reject and unlearn the ways we've been taught to view our bodies (fatphobia, racism, sexism, gender rigidity, consumerism, ableism)—when we appeal to some notion of an unmodified or undecorated body, we participate in the adoption of a false neutrality. We pretend, in those moments, that there is a natural body or fashion, a way of dressing or wearing yourself that is not a product of culture.

Norms always masquerade as non-choices." (Spade) Thus the performer succeeds in de-neutralising the body and unlearning the body from its institutionalised experiences through their acts.

Panteha Abareshi is a Canadian-born American multidisciplinary artist who works primarily with installation, video, and performance. Abareshi's art practice roots in their existence living with sickle cell zero beta thalassemia - a genetic blood disorder that causes debilitating pain. She keeps exploring her identities through the "malfunction", "otherness", and "illness" in her own bodily struggle and embodied social experience. In socially accepted norms, her body is treated not like a body — the lack of representation and misrepresentation of the complexities of living within a body that is highly monitored and constantly examined has alienated her body almost into a specimen. Abareshi said, "my body is truly treated as a pound of flesh, the vitals that it produces, and the malfunctions it abounds in. In my performance work, I am pushing my own vulnerability and objectification to discuss the realities of mortality and fragility, and the complexities of empowerment in the face of literal powerlessness." (Abareshi) By taking images of recognisable human forms and reducing them to gestural shapes, she juxtaposes her own body's objectification and dissection.

In Abareshi's video performance work Unlearn the Body (2020), she renders her body as an object that clambers atop crutch handles, entangles itself with walkers, and tumbles through the bars. By fully exposing her vulnerabilities as she moves and interacts strangely with her mobile devices in front of the camera, she empowers her absolute powerlessness under the indifferent cold camera lens of examination. She goes on about her practice of subverting the notion of identity, "Identity as we know it is so highly linked to bodily form, and linked to aspects of bodily existence that are taken for granted. I aim to explore these questions in this region of identity, pushing to articulate my own fears, insecurities and confusions around my illness-identity." (Abareshi)

If we look at both Sherman's photographic and Abareshi's film,

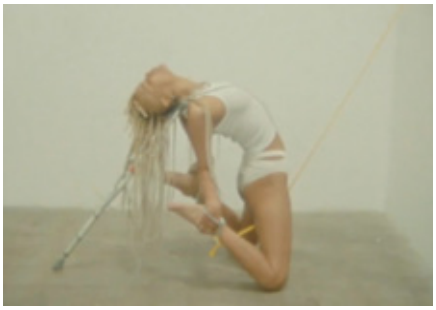

Fig.2. Abareshi Panteha, *Unlearn the Body*, 2021.

there is a shift in the notion of identity, from 'who we are' to 'with whom we connect'. Both their work mediate through the camera lens and pose their ideas on the neutralisation and disempowerment of identity systems to a larger related audience. Comparing to the audience in theatrical settings who is constantly evolving in the identity-making procedure, the user in art performance becomes distanced and irrelevant. The performer devotes themselves to impressing or frustrating the camera through their performance, which reflects and re-envisions both their personal and cultural identities at large. The camera becomes the gaze,

the normalising power behind the mass media, and the performer has the agency to do whatever they want in front of it.

There was a perception that the video camera could undo the power structures of the media landscape when used independently, and could potentially undermine the politics and norms of mass culture. As stated by curator Glenn Phillips, "The promise held by video, that it could create 'personal media,' that normal people could control the production of video imagery and bypass tightly controlled corporate structure of commercial media, seemed like a revolutionary and democratic advance (Gauthier 2019, 3).

2.3. Performativity and moving into cyberspace

After the unfolding of the power/resistance relations in art performance and the discussions around its subversion of social political power structures in identity ontologies, there comes the perfect timing to discuss the concept of performativity. Performativity is not to be confused with performance. Performativity is a process concept that seeks to escape – or at least to reject – the dualism of structure and agency (McKinlay 2010, 234). It is the materialisation of norms, a process that is inherently unstable, latent with the possibility of resistance. Performativity refers both to the fragility and the stubborn consistency of identity (McKinlay 2010, 235).

Performativity is also a transition from individual struggles within the memories of their own bodily experience to a collective consciousness. As Butler points out, "Performativity is a collective, political endeavour" (Butler 2016, 498). It affirms the credibility of its own production through self portraits and projects an ideal through media for the audience to interact with.

Butler dissects the notion of performativity. She points out that there are two forms of performativity: mimicry and citation (McKinlay 2010, 235). Inescapably, any identity can't be developed through the void of pure imagination. Even with alternative identities that act as protests of the hegemonic identities — they are the reactions to the pre-existent structures, which means identities are mimed or imitated in the everyday practices and speech of individuals. Therefore, identity of any kind involves mimicry. Mckinlay further clarifies that "Mimicry sits uneasily and ambiguously between identificatory collusion and the subversion of a given, ascribed identity (McKinlay 2010, 237). Quite where the act of mimicry sits is dependent upon the degree of readability and intentionality." In Butler's Gender Trouble, she argues that the key to claiming the leading identity is through the repetition of prescribed language that lends itself to mimicry, a form of reiteration that signifies the inherent instability of established language and identity. The second mechanism of performativity to be considered is citation. According to Mckinlay, "citation is the process of enacting a self-identity that is linked to a wider imagined community and tradition", (McKinlay 2010, 238) which corresponds to Butler's statement on performativity being a collective establishment. Hereby we need to address a question: If Performativity is formatted as mimicry and citation, what is its relation to "authenticity"? How do we validate their readability in its complexity? Shoshana Felman argues that individual identity is always and necessarily a failing project in which one can never achieve anything other than an approximation of a 'real' identity. Each moment of mimicry and

citation represents not, then, an acting out of an identity but the pursuit of an imaginary, impossible ideal (Felman 2003, 42).

Most importantly, performativity confirms the autonomy and authority of the subject, which provides us with a different power apparatus against social political institutions: we as performers can enact the full potential of identity fantasies, struggles, or desires. We are finally eliminating the shame — the shame of being incapable to perform socially prescribed identities, and taking back the agency of deciding our own bodily realities.

Performativity does not only manifest in art but also permeates all aspects of our daily life. As Butler puts it, "the enactment of identities in everyday life roots performativity in mundane daily experience." In cyberspace, the idea of performativity seems to apply essentially in the phenomenons of our digital life on social media. We, as digital citizens are in fact, constantly performing our identities in our daily networked interactions.

We will be looking at the materiality of social media, ...to dissect the phenomena where people either voluntarily or involuntarily perform on social networks. Danah boyd, one of the most prolific scholars in the field, defines Social network sites(SNS) as:

Web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection and (3) view and traverse their list of connections and those made by others within the system (Van Doorn 2010, 584).

Because of the fast-developing speed of technologies and social media updates, this definition Boyd coined in 2007 might needs an update, but it still provides a general framework for understanding SNSs and our popular social networks of today.

Comparing to physical performance where the physical body has to be present, our digital performative acts require no physicality to enact. Butler's stand on "identities enacts through embodied experiences and acts" (Butler 2015) falls out of element in the digital arena too. Furthermore, going back to Goffman's theory on "front stage" and "back stage", (Goffman 1990) actors in digital performance make no transition between their "performing status" and "off status", considering the digital and physical spaces have been inherently blended with each other through the easy accessibility and mobility of our digital devices. This absence of physical interaction with our body might obfuscate the fact that we are performing — since we might not realise when we put on the "costumes" to perform in cyberspaces and take them as an underlying part of our pre-established identities. Therefore in our present ubiquitous tech-led world, with people leading more omni-channel lives, our online and offline lives are becoming harder to discern.

Our online profiles incarnate into our digital bodies and provide the social context for interactions in a space that lacks both a physical infrastructure and a visible audience (Van Doorn 2010, 585). Instead of deriving social norms from other people's embodied presence, users have to create and interpret the semiotic resources (i.e. text, images, videos) that make up their profiles, which effectively constitute a digital infrastructure (Van Doorn 2010, 588). That being said, digital performance can be undertaken not only with talk, symbols, and objects which are claimed the 'social' elements in impression management theory, but also with texts, emojis, internet 'Readymade', interaction materials, etc..,

which provides new possibilities and alternatives to construct/deconstruct self portraits online. Cindy Sherman embarked on the exploration of her digital identities on social media too. Instead of setting up the whole scene, changing outfits, and even putting on prosthetic body attachments, she uses social media as tools to achieve her body dysmorphia just as she intended to do in her previous works. Her instagram, once was private, now has become a repertoire of her wildly distorted selfies, flower arrangements and disturbing hospital self-portraits, with oxygen tubes up her nostrils (Becker 2017). With the aid of digital filters, editing, and post-processing, her self portraits become even more dramatically morphed into fictional creatures. The work seems to be made specifically for Instagram, and not as a physical work for a future show in a gallery. They are created specifically for the lens of social media, weaved into the nature of digital performative behaviour.

Fig.3. Cindy Sherman, Instagram posts, ongoing.

Sherman does not primarily perform for the camera anymore — But for an expansive but invisible audience constituting an online social network. These interactions dialogically produce a shared social reality through the distribution and interpretation of these artefacts. In other words, the meanings produced on the profiles are not the accomplishment of individual performances, but instead are an effect of the cultural negotiations that take place within a network (Van Doorn 2010, 594).

The representation of self transits into a communicative body. boyd and Heer further explore the relationship between identity and the online social network, examining how users simultaneously construct themselves and others on their profiles (Van Doorn 2010, 596). They argue that the construction of a personal profile on an SNS is not an autonomous effort, but instead the result of continuous interactions with one's online social environment. With the hyperconnectivity and hybrid identity epistemology in the nature of digital performativity at play, the collective attribute that Butler stresses grows exponentially in cyberspace. Hence we are going to look into a form of emotional contagion as a factor that motivates digital citizens to perform compulsively.

One study researched emotional contagion on social media with a series of experiments. Emotional states can be transferred to others via emotional contagion, leading people to experience the same emotions without their awareness. In an experiment with people who use Facebook, they tested whether emotional contagion occurs in online interac-

tion between individuals by reducing the amount of emotional content in the News Feed. The result shows when positive expressions were reduced, people produced fewer positive posts and more negative posts; when negative expressions were reduced, the opposite pattern occurred (Kramer 2014). The conclusion from the study is the observation of others' positive experiences on social media constitutes a positive experience for people. Therefore there is a chain reaction of feedback on our digital performativity: a butterfly effect of emotion that takes effect unconsciously and drives us to perform.

Kathleen Hartnett, a researcher on social media behaviour pointed out the usage of dramatic expressions in digital networking interactions in one of her talks about Digital Ethnography. People often exaggerate their emotions in online communications, which is often perceived as "dramatic", "narcissistic", or even "fake". One example is our usage of all capitalised words or extreme expressions to show our emotions like "I AM DYING," "LOLL" in digital communications. She further analyses the phenomena and suggests two main factors at play: firstly these kinds of behaviour demonstrate how performative behaviour seeks attention in the noise of digital interactivity, in the explosion of content in cyberspace; secondly it is driven by a form of emotional contagion/feedback system — when people receive performative emotions from others, they tend to react in the same emotional intensity or even higher to match the received level of expression from the other end of the device, to meet up certain expectations and not disappoint the user on the other end (Harnett 2016).

The desire to be seen, to be noticed besides the emotional contagion factor in Hartnett's example is also intriguing — Without the presence of our physical bodies, how do we make sure we are being perceived and connected in the digital social network of potential audience? The performative capitalised words in our webchats, are they act to insert our power for representation? Does this excessive power and agency elicit certain anxiety or shame that pushes us to perform?

"Language has been granted too much power," Karen Barad claims in her book "Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter". She further explains that performativity is precisely a contestation of the excessive power granted to language to determine what is real (Barad 2018, 238). Hence, in ironic contrast to the misconception that would equate performativity with a form of linguistic monism that takes language to be the stuff of reality, performativity is actually a contestation of the unexamined habits of mind that grant language and other forms of representation more power in determining our ontologies than they deserve (Barad 2018, 232).

Barad's thoughts on "the excessiveness of power" that performativity grants us are thought-provoking. The power evokes a "reversed shame", a shame of not fulfilling the 'ideal' that performativity projects through productions of self, referring back to Butler's statement (Barad 2018; Butler 2016). It is not the shame from the gaze in theatrical performance where the actor fears not achieving a prescribed belief, but the opposite — they are scared of not being capable of presenting the complexity of their identities within their given power, unseen and unheard. This reversed shame magnifies our desire and anxiety over our

image. We do because we can, and because others are doing it — we are performing for the sake of power at our hands to some extent.

Molly soda is a web artist who works on a variety of digital platforms, including multiple social media outlets like Tumblr, Twitter, and Instagram to produce selfies videos, GIFs, zines, and web-based performance art. Her art website looks like a digital gallery, or a digital assemblage of her online persona, displaying all her work in a collaged fashion, being scrutinised under the digital gaze.

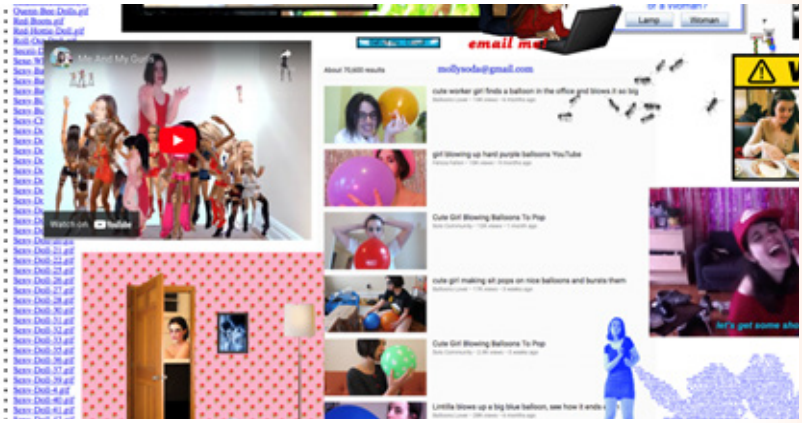

Fig.4. Molly Soda, website, ongoing.

Molly Soda expresses that she feels a sense of belonging in social networks, like she has the control to be fully represented through her performances. In Soda's work, 'shame' has been a drive for her to perform for the digital media: "I'm really interested in why you feel embarrassed about something, why something is shameful to you. How to pull that out of yourself, how to deal with it. In a lot of ways, it comes from a sense of self-protection or control" (Geffen 2018). Think about the notion of shame as a constantly shifting and interactive consciousness — it is heavily impacted by interactions and feedback we expect or receive. Molly states that a lot of her work deals with the reactions that people give her: secondhand embarrassment they might be feeling or shame attached to something they see. But the premise of getting feedback is that her work is being seen and digested by a fairly large audience. She talks about the attention-seeking in digital networks: "It's the Pavlovian bell. We are all looking for the food bowl with the bell." (Geffen 2018) So the question is, does the importance of being seen overweighs what we are trying to say within our identity performance?

Barad believes that "one's identity exists insofar an intra-activity involving meaning and matter takes place" (Barad 2018, 227) – before this, neither meaning nor matter would exist. She argues that it's more of a power game, in her own words as "... bring to the forefront important questions of ontology, materiality, and agency, while social constructivist approaches get caught up in the geometrical optics of reflection where, much like the infinite play of images between two facing mirrors, the epistemological gets bounced back and forth, but nothing more is seen" (Barad 2018, 225).

In conclusion, digital performativity is embedded in its materiality, intra-action of its social-political network, shame/anxiety over self-image, and power exhibition.

2. Slippage between agency and cyber performativity

While digital citizens hail the sovereign individual of liberalism in their identity performance, McKinlay points out that there is nothing original or purely driven by our agency — the appearance is just the disguise of established authority: "the individual is, so to speak, merely quoting an already established set of conventions. This is a process of quoting that conceals its own status as quotation" (McKinlay 2010, 235).

In her book The Age of Surveillance Capitalism Shoshana Zuboff quoted what a Google software engineer once said, "The goal now is to automate them. We are learning how to write the music, and then we let the music make them dance" (Zuboff 2020, 14).

In this section I purpose that digital performativity is actually automated — there is a slippage of agency and our performative behaviour is manoeuvred by tech corporations for their capital gain. Performativity in cyberspace is essentially a highly monitored human future market where humans produce and transact their identity as commodities. I will draw from a few discourses to substantiate my statement including Surveillance capitalism, belief and feedback system, agency, and object-oriented identity.

Our network life and interactions can't exist without infrastructures built by tech corporations, which means they also own our online data when they provide us with their service. Our data are constantly being surveilled, tracked, and sold to all types of corporations in digital networks. Zuboff refers to digital human data as "free raw material" or as Bruce Schneier called them "human natural resources"(Naughton 2019) for Surveillance capitalists to trade for production and sales. Parry Page materialises and compares our digital bodies, thoughts and feelings to nature's meadows, rivers, oceans and forests, implying a future where these human materials will be exploited and fall into the market dynamic (Naughton 2019).

As we discussed in the first section of the essay the audience of digital performativity is rendered as an expansive but invisible social network constituted by individual users — but the underlying infrastructure inhabits the power dynamic between all users and the capitalist counterpart: "The combination of state surveillance and its capitalist counterpart means that digital technology is separating the citizens in all societies into two groups: the watchers (invisible, unknown and unaccountable) and the watched" (Naughton 2019).

Further, the watchers are not satisfied by only profiting from the raw digital human data, they are moving in the direction of building predictive behavioural models with our raw data. It is a reorientation from knowledge to power — that it is no longer enough to automate information flows about us; the goal now is to automate us (Zuboff 2020, p.14). The predictive models aim not only to predict our behaviour but also to modify our actions for the most profitable outcomes. Zuboff calls it "a behavioural futures market that sells human futures", from which new forms of social inequality have emerged and it is inherently anti-democratic."

Even though these predictive networks are fed off our identity materials, companies take full ownership of them. They lurk in the dark and mine every move of ours without our awareness. At the grassroots, systems are designed to evade individual awareness, undermining hu-

man agency, eliminating decision rights, diminishing autonomy and depriving us of the right to combat (Naughton 2019).

Surveillance Capitalists are becoming the puppetry masters, rather than those scriptwriters in theatres who exert power on the performer on the front stage — They dressed in the fashions of advocacy and emancipation, appealing to and exploiting contemporary anxieties, while the real action was hidden offstage (Zuboff 2020, 14). Quoting back on Felman and Hollywood's view on 'the impossible ideal' that identity attempts to mime and approximate, and "each moment of mimicry and citation [in performativity] represents not, then, an acting out of an identity but the pursuit of an imaginary, impossible ideal," I propose that the watchers/behavioural futures market holders have carefully constructed 'the ideal' and inserted beliefs in our brain, then "empower" us to pursue them with our insubstantial agency endlessly for profit (Felman 2003; Hollywood 2002).

I will use the beauty culture on social media as an instance of how capitalists steer our behaviour with constructed beliefs. Liz Barr addresses her view on 'beauty': "Beauty is about work. But if you wear makeup, it's supposed to be subtle and "natural" looking, like the "no-makeup makeup" trend. The "no-makeup makeup" trend or #No-Makeup movement on social media aims to encourage women to embrace their natural beauty and post makeup-free selfies. If you search on Instagram, there are over 20 million posts with the hashtag "nomakeup" on them. And what do these photos look like? Photos featured people with nice glowy skin, sun-kissed tan, and cute freckles get more likes and comments. "'No-makeup' makeup sounds like an oxymoron. But ask anyone in the beauty industry, which is valued at $445 billion, and they'll tell you a good chunk of those photos tagged #nomakeup online actually require multiple cosmetics to look so 'natural,'" explains Leigh Beeson of the University of Georgia (Sternberg 2021). They are projecting an illusion, an ideal of beauty here: that beauty is natural and can be achieved without effort. As a result, this impossible ideal of beauty solidifies into a reality with exposure and positive feedback they received, which intensifies our anxiety about self-image and manoeuvres us into the pursuit of an impossible mission of "natural beauty". But how are people performing this effortless beauty role? Ironically, by buying more cosmetics or skincare products — the no-makeup movement has been great for business, consumers have been spending higher levels of disposable income on cosmetics than they had in the past, according to Statista (Sternberg 2021).

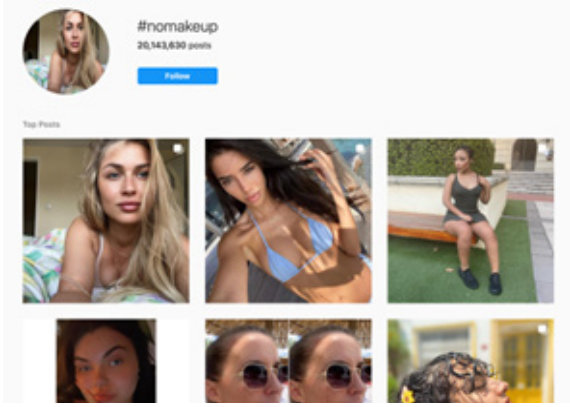

Fig.5. Instagram Search "#nomakeup".

Ian Cheng's work Bag of Beliefs showcases an AI creature whose personality, body, and life script evolve across exhibitions. It is a simulation that focuses on an individual agent's capacity to deal with surprise: the subjective difference between expectations and perception (2020). The agent evolves when it is upset, which occurs when there is a mismatch between its beliefs and the realities. In other words, if the agent's beliefs do not correspond to the world's "realities", the world upsets them. The agent then has to prove itself again, by updating its beliefs. The positive feedback is given to reinforce its bias and trust in the world's realities, and "we deny these artificial systems the status of sentience when they have no skin in the game of self-legislation," says Cheng.

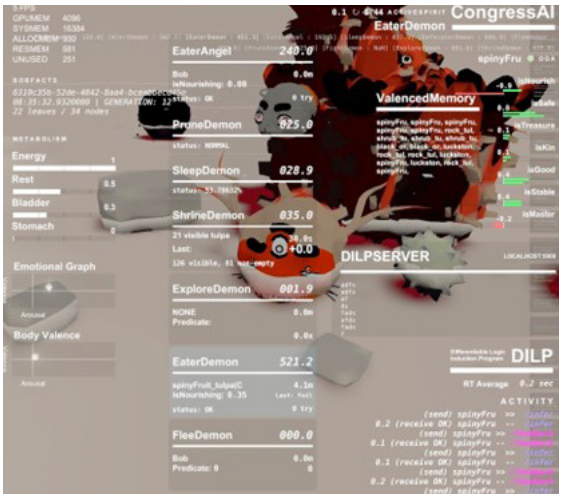

Fig.6. Ian Cheng, *Bag of Beliefs*, 2020.

'The status of sentience' symbolises digital performativity in our digital lived experiences, where we perform to approximate the constructed ideals, and maintain seen and relevant in cyber networks. Katherine Behar investigates the materiality of identities through the lens of object-oriented ontology, where she argues that "secondary qualities of people objects are becoming detachable and remixable independent objects." It coincides with Carl Jung's theory on subpersonalities — "Identity is a collection of subpersonalities, each with their own motives and a preferred subset of beliefs" (Jung 1996, 183). Digital performativity is the automated making and unmaking of identity — transactions of human future commodities to feed in surveillance capitalism's surplus flows. Just like what Behar says, "like how we see objects: we use them, we display them, we discard them" (Behar 2018).

3. Conclusion

They are learning how to write the music, and then they let the music make us dance. Digital citizens have incarnated into Sisyphuses trapped in the dreams of emancipation that surveillance capitalists sell us. How do we reclaim the agency in our digital performativity? As the era of Web 3.0 is approaching, maybe it is time for us to think about the possibilities of creating alternative digital networks to habitat in.

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Performative Architecture as a Theatrical Performer: A Technological Extension to Dancers' Movements

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Performance is perceived as a harmonious interplay between the performer and the space. Many elements at work contribute highly to an artistic act. History has witnessed the efforts made to activate the role of performance spaces towards interactivity and adaptivity, including more advanced stage designs that respond to the changing needs of the performer. However, architecture today frequently remains static rather than offering an immersive foreground experience to enhance audience engagement actively. With the advent of soft robotics and its required computation, architecture can input real-time performance data and generate form-changing movements, creating new sensory experiences that inspire and enrich subject-agent feedback. This article explores innovative means to enhance engagement by foregrounding architecture. Through social and design investigations, the study hypothesised the performativity of spaces as a spectrum ranging from immaterial sensory experiences to shape-changing adaptive systems. A case study was developed around two live performances in London, with user surveys focused on impacts, immersivity, and engagement. Principles were then abstracted and applied to propose the design of novel robotic spatial systems, where architecture becomes another layer of skin in an innovative theatrical experience - space, subject, and agent becoming a new trilogy of performative events.

1. Introduction

1.1. Vision

Imagine this scenario: you immerse yourself in a dance performance, where the boundaries of the space around you come alive, shifting, and adapting in harmony with your choreography. As you gracefully execute each movement, the architectural elements that comprise your surroundings become responsive, mirroring and supporting your dance with seamless synchronicity. In this remarkable exchange, the envelope itself becomes a performer, evolving alongside you.

The architectural components extend and enhance your movements, connecting you with the audience as an invisible bridge. As you navigate this dynamic relationship, the space opens new possibilities, inspiring you to explore dance sequences. This mutual exchange of creativity and expression between you and the architectural elements profoundly impacts those who resonate with your performance.

In this transformative experience, architecture ceases to be a static backdrop and assumes an active role, becoming a collaborator and co-creator. Together, you and the adaptive space transcend traditional

Keywords Adaptive Systems, Immersivity, Performance Spaces, Soft Robotic Systems, Sensory Experience, User Engagement.
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boundaries, offering an immersive and unforgettable performance that blurs the lines between performer, environment, and audience.

1.2. Objectives

In an ever-changing society, new technological mediums present the art of performance with the critical opportunity to evolve, transporting spectators into heightened immersion (Murray 1997). Embracing this emergence can potentially revolutionise how we perform and engage with performances, offering novel sensory experiences through adaptive structures.

Adaptive architecture, sometimes called responsive or dynamic architecture, encompasses design principles and systems that can assume multiple configurations over time while adapting to evolving conditions and user requirements (Schnädelbach 2010). This approach involves incorporating technology and responsive mechanisms to construct buildings and spaces that can dynamically alter their shape, purpose, or environmental conditions in real time (Sumini et al. 2009). As such, spatial form-finding is not merely a quest for the most efficient shape but a source of insight into agency distribution (Ng et al. 2021). However, the research gap between changing spatial quality and audience experience limits our understanding of adaptive performance space design.

This article explores the shift towards interactive design in architecture, emphasising the rationale through questionnaire analysis and presenting a catalogue of extracted environment sets, which envision the aesthetic aspects of robotic structures and propose design strategies. The objectives are a) to examine various types of performing spaces, centring on the spectrum of ‘Space as a Performer’; b) to draw insights from live performances and develop a case study of the performing areas; c) to understand audiences’ varying experiences through questionnaires; d) to explore the potentials and significance of physical space as an adaptive and active participant in performances, moving beyond a static backdrop. The outcomes and experiences documented contribute to integrating soft robotics systems in constructing the envelope of performance spaces for enhanced theatrical possibilities.

2. A Closer Look at Spaces as Performers

Artists typically showcase their talents in traditional performance spaces but venture into unconventional or informal spaces like streets, squares, parks, metro stations, and tunnels (Ault 2002). From the lineage of performing spaces over time, many elements contributed highly to its sensory and immersive experience advancements. These elements are divided into the subject and the agent. The subject is the free independent element that is the performer, whereas the agent is an additional yet essential element dependent on the subject. By delving into the diverse ways space can evolve into a performer, designers may begin to understand their impacts on the audience. Four observable approaches to conceptualising space as a performer emerge through precedent analysis: subject removal, immaterial agents, interactive elements, and adaptive robotic systems.

The first approach removes the subject simply. Usually, the performer and the spotlight become the agent of the space (Kipnis 2002). We can find examples where the architecture or design of space takes

precedence over traditional subjects. The Wexner Centre by Peter Eisenman removed paintings from the gallery, shifting focus to the spatial form such that the architecture becomes the foreground (figure 1). By removing the subject or shifting focus to the agents, these approaches challenge traditional notions of performance and spectatorship, where architecture becomes an integral part of artistic expression. They encourage active participation and exploration, creating immersive and multisensory experiences.

In a performance setting, we could see this type of 'Space as a Performer' in digital arts (Saddler 2023). The Now Building is nestled beside the Elizabeth line entrance of Tottenham Court Road station, which hosts a 23,000-square-foot immersive wonderland. It features floor-to-ceiling digital art, providing a vibrant escape where the space transforms into a captivating spectacle of immersive digital art.

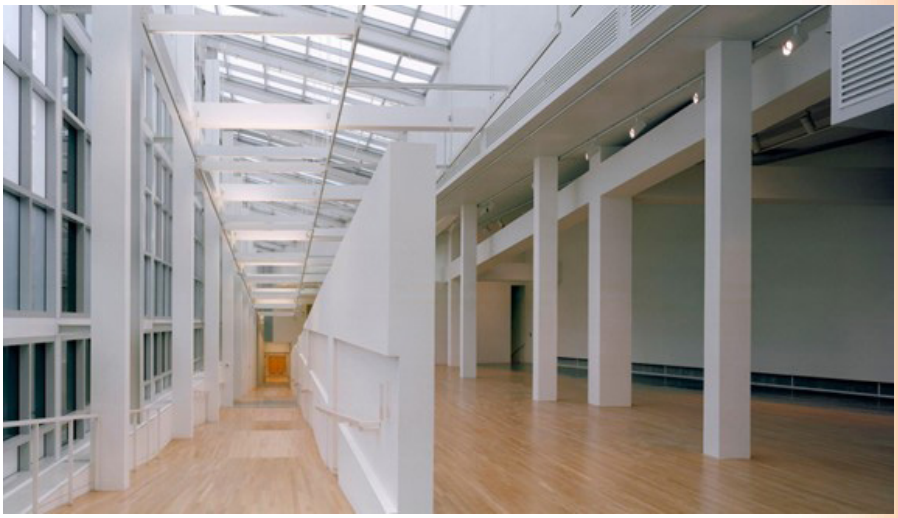


Fig.1. The first approach: subject removal, exemplified by the Wexner Centre. Image credit: Brad Feinknopf.

The second approach is to manipulate space through agents, either through articulating light, shadows, and colour variations to meld the form of the interior or using visual effects with display movements to create a sense of change and mobility (Petridou 2024). Borderless by TeamLab exemplified the approaches: all the different performative spaces have no performer (figure 2). The agent, the visual projection, becomes the main spectacle. The space caters to an immersive experience using interactive screens displaying a moving landscape that blurs the physical and digital boundaries. Space became an interactive and transformative entity, engaging the audience through visual, auditory, and sensory elements while they actively explored the environment.

Further exemplified in the exhibition Synchronicity at 180 by Strand, London, the electro-artistic collective United Visual Artists skilfully uses light and sound to question the fabric of our perception (figure 3). In this latest showcase, they adeptly transformed the sublime into an occasionally ominous experience, using light to transform the perception of space or the reality of the person in space and giving a sense of change and movement not from the space itself but from the perception inside. Pieces like Polyphony and Chromatic highlight the interplay between light and sound, while others such as Our Time and Edge of Chaos create tension by manipulating an unsettling emptiness, a cautionary

exploration that underscores our dependence on light, inducing a sense of unease and intended objective.

Fig.2. The second approach: immaterial agents, exemplified by Borderless. Image credit: TeamLab.

Fig.3. The second approach: immaterial agents, exemplified by UVA. Image credit: Synchronicity by UVA.

A third approach is having interactive elements within the space, but the overall boundary of the space remains static (Wiseman et al. 2017). Within the domain of stage design, there exists a dynamic and adaptable landscape where various elements beyond the stage itself are ingeniously manipulated to suit the evolving demands of performances. This includes introducing movable components such as set pieces, props, and even suspended elements from the ceiling. Additionally, the ground may feature openings or platforms that can rise or descend, creating new dimensions and levels for performers to engage with. These dynamic features contribute to a rich and immersive theatrical experience, enhancing the performer's interaction with the space and captivating the audience's imagination.

Translating and expanding concepts of adaptive stage design to the architectural realm, one example is the dynamic roof exemplified by BO18 in Lebanon (figure 4). Situated underground beneath a parking lot, the nightclub BO18 features a roof that opens during sunrise, allowing sunlight to permeate the space—a symbolic closing gesture to mark the golden sunrise in Beirut. While not a continuous interactive feature, this transformation occurs at a specific moment, introducing a distinctive experiential attribute that contrasts the before and after states.

Fig.4. The third approach: interactive elements, exemplified by a Beirut nightclub. Image credit: BO18.

Yet, a less commonly observed fourth approach takes a more literal route, employing robotic systems to facilitate shape-changing within the overall boundaries of the space as an integral aspect of the performance. Adaptive architecture facilitated by such autonomous systems are classified into two main categories: soft robotics and rigid robotics. The former employs flexible and compliant materials like elastomers, textiles, or pneumatic systems, allowing for deformations and adaptability in the system's structure (Stepanyuk 2023).

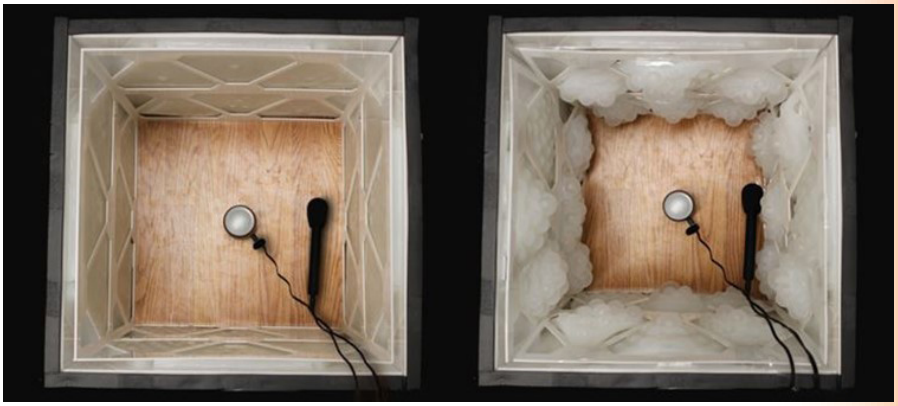


Fig.5. The fourth approach: Adaptive robotic systems, exemplified through project *Soft Acoustic Tile*. Image credit: MDL, Ryan Berg, Paulo Guerreiro, and Jesus Vasquez.

The central approach for their actuation depends on material intelligence using pneumatic and/or bending active systems to create the transformable element (Alici 2018). Pneumatic systems can change form by applying air pressure that can deform the form state - material intelligence - how the material behaves through manipulation and sealing techniques. Unlike rigid bodies, soft systems can deform more delicately. For example, consider the *Soft Acoustic Tile*, which employs a pneumatic, silicone-based soft robotic design activated through sound sensors. This innovative approach harnesses air as the means of actuation and as the medium for modulating the system's acoustic characteristics (Fig. 5).

Rigid robotics typically uses rigid structures and materials such as metals, plastics, and composites. These materials provide stability and rigidity to the robot's design. Also, they use stiff joints and linkages to achieve precise and controlled movements. Doria's paper on interactive pavilions presents an analogous case study (Doria 2016). The spatial design dynamically alters its internal form based on sensors and the user's location, providing a detailed technical approach, and exploring the feasibility of adaptive structure. This study aligns with the broader theme of developing interactive architecture to shift the traditional passive-reactive relationship between users and buildings. The envisioned outcome is a continuous exchange of influence and actions, challenging the conventional closed nature of architectural objects.

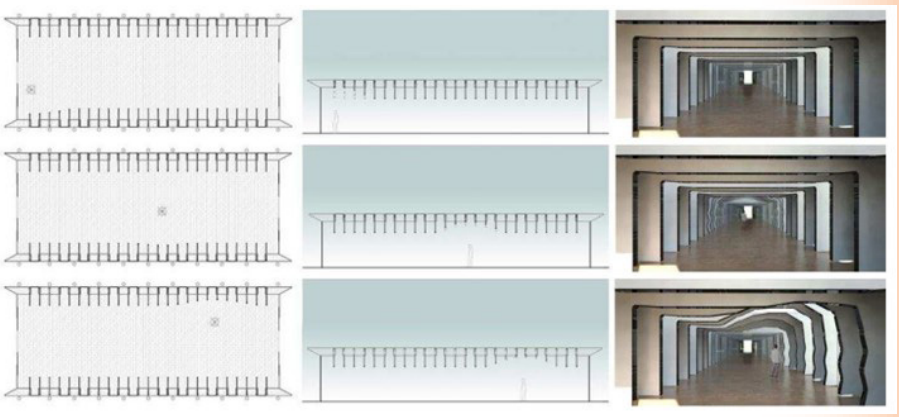


Fig.6. *Interactive Pavilion* Storyboard Concept. Image credit: David Doria.

3. A Compass of Performative Architecture

Drawing from these insights, a compass of performative architecture is formulated, with all elements representing a continuum between these extremes (figure 7). The compass referenced Janet H. Murray's (Murray 1997) theorisation of immersive realities and performative agents. Immersivity refers to being contained in a space or a state of mind through assumptions and actions. In contrast, the agency was defined as the aesthetic pleasure that arises from skilfully leveraging the procedural and participatory elements within digital environments.

The horizontal axis transitions from immateriality to complete adaptability. The vertical axis points to the quality of agents curated within a space — "space as performer" foreground architecture as the primary agent, whereas "space as immersion" discusses the interplay between the static and the installed to create a state of mind.

Together, the compass facilitates four areas of design approach for adaptive performance spaces. "Subject removal" foregrounds architecture by removing entirely the human performer, a form of immateriality. "Robotic systems" do the same but differ by focusing on adapting spaces to human agency. "Immaterial agents" immerse audiences by manipulating atmospheric quality and environmental parameters, whereas "interactive elements" rest on articulating physical structures.

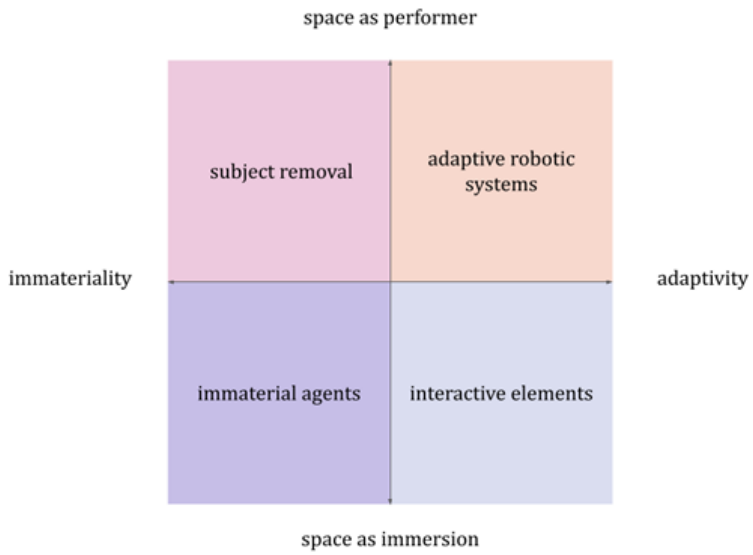


Fig.7. A compass of performance architecture, formulated from precedent analysis.

Curation is achieved when the agency of space is synchronised with that of the subject, resulting in a more captivating and interactive experience. One common factor between the approaches is the increase in interactivity as agents increase, for instance, shifting from a fixed viewpoint to a 360-degree field. Also, both axes transition from a limitation on the role difference between the space and the audience, reaching a no-boundary system between them. The axes signify a shift towards greater user engagement through interactivity. Although the domains differ, some focus on physical spaces, while others focus on media experiences, all coordinates share the underlying principle of progression. The performative effect resulting from such spatial transformation contributes to subject-agent feedback.

4. Methods

The study approach combines methods of case study, social survey, and design experiments. The goal is to understand how audience experience can be enhanced by foregrounding performative architecture as a theatrical agent, deriving a set of design principles.

4.1. Comparative Case Study

Two live performances in London were chosen for the case study for their differing levels of interactivity, providing insight into how individuals engage with varying degrees of interactive experiences. The authors attended the music show in-person; the process was recorded via field notes detailing the qualities, hand-sketch illustrations, and photo documentation.

- Case study I tried to understand the relationship between subjects and agents in the two performances, labelled A and B.
- Case Study II studied two performance spaces, labelled X and Y.

Our overarching objective is to construct a new trilogy that integrates these components into a design system, with strategy to enrich the audience experience.

In framing our design approaches, it is imperative to highlight the challenges surrounding audience experience, supported by results of social survey analysis. These challenges will serve as the focal point, driving our research forward and guiding our efforts to enhance engagement.

Finally, all is consolidated into a set of four strategies. By comparing parameters between performances, strategies and techniques that can contribute to a more satisfying, immersive, and engaging experience, the strategies were identified to inform future performance spaces and practices.

4.2. Social Survey

A survey was tailored to explore the impacts, immersivity, and audience engagement of performative spaces (refer to appendix). A questionnaire was structured to encompass various parameters, specifically in enjoyability, performance rate, connection, resonation, engagement, experientiality, and overall satisfaction to capture participants' experiences and perceptions effectively.

Participant Sampling

Participants of Case Study I were convenient sampled from audiences immediately following the end of performances A and B. In Case Study II, participants were recruited via social media platforms, targeting individuals who had attended the Thin Air exhibition.
There were thirty-two responses from participants for Case Study I, and fifty responses for Case Study II, who were asked to reflect on their overall experience separately, describing the atmospheres to establish a baseline measurement. This summarises participants' overall impressions concisely and provides a quick snapshot of their feelings.

Questionnaire Design

The questionnaire was sectioned for Case Study I to thoroughly evaluate participants' experiences and perceptions of performances A and B. The design of the questions prioritised clarity, conciseness, and impartiality. The sections of the questionnaire were as follows:

- ***Performer Comparison***: Participants were prompted to compare their performances.
- ***Satisfaction Ratings:*** Participants rated their overall satisfaction with each performance on a scale of 1 to 10, enabling quantifiable feedback.
- ***Engagement Assessment:*** Participants assessed their level of engagement using a Likert scale ranging from "Not engaged at all" to "Extremely engaged," offering insights into their connection with the performances.
- ***Experimental vs. Traditional Perception:*** Participants categorised each performance as experimental or traditional, reflecting their perception of the performances' innovative or conventional nature.
- ***Overall Impression:*** Participants indicated which performer's live electronic sounds left a stronger impression, capturing the lasting impact of the performances.
- ***Audience Resonance:*** Participants identified which performance they believed resonated more with most of the audience, providing insights into audience preferences and collective experience.

For Case Study II, the questionnaire was structured to comprehensively assess participants' experiences and perceptions of Spaces X and Y at Thin Air. The design of the questions emphasised clarity, conciseness, and impartiality. The sections of the questionnaire were as follows:

- ***Immersivity Comparison:*** Participants were asked to compare the immersivity of Space X and Y at Thin Air.
- ***Satisfaction Ratings:*** Participants rated their overall satisfaction with each space's performativity at Thin Air on a scale of 1 to 10.
- ***Impact on Audience:*** Participants were prompted to identify which space they felt had a more substantial effect on the audience.
- ***Resonation:*** Participants indicated which space resonated more with them.
- ***Engagement Assessment:*** Participants assessed their level of engagement with space X and Y at Thin Air using a Likert scale ranging from "Not engaged at all" to "Extremely engaged."

The questionnaire's design aimed to facilitate clear and concise feedback while maintaining impartiality. Likert scales were employed to allow for quantifiable ratings of satisfaction and engagement, standardising the assessment of satisfaction, engagement, and perception and enhancing the reliability of the responses. These structured questions were intended to provide comprehensive insights into participants' experiences and preferences regarding the immersive performances. Electronic distribution through social media platforms maximised accessibility and participation efficiency.

5. Comparative Case Study I: Agents and Subjects

5.1 Performances: Live Music

Performance A featured two DJs who crafted their acoustic percussive with analogue instruments using bolts, strings, carbon, steel, and electronic devices to produce sound. They controlled the sound by manipulating the bolts and machinery, adjusting knobs for specific volumes and frequencies. The performance occurred in an outdoor venue arranged in a loose interpretation of a proscenium typology, with an elevated wooden stage for the DJs and parallel seating providing a clear view of the performers.

In contrast, Performance B, led by a composer and performer, employed a more interactive approach using robotic integration to generate electronic music. The artistic practice revolves around designing hybrid instruments, developing software, repurposing hardware, and manipulating improvised vocalisations. Collaborative efforts with dancers, visual artists, and instrumentalists are also integral to the compositional process. Motion sensors were attached to the arms in the performance, translating hand gestures and body movements into electronic sounds. This work was imbued with a dynamic element where sound was generated through motion rather than direct control. A wearable collection of motion sensors was created using a microcontroller system known as Arduino. Each movement detected by the sensor was coded to a different generation of sound worn on the performer's hand. Each specific movement generated a corresponding sound intricately linked to the movements' swiftness, speed, or angle.

Table 1. Summary of the comparison between the two performances.

PERFORMANCE A	PERFORMANCE B
Electronic Music	Electronic Music
Created their own instrument	Created their own instrument
Analogue Control	Digital Control
Sound was controlled	Sound was generated by movement
Performance outcome focused on sound	Performance outcome focused on Sound and Movement
Loose Proscenium Layout Typology	Loose Proscenium Layout Typology
Outdoor Setting	Indoor Setting
Around 50 viewers	Around 50 Viewers
Same Audience of Performance B	Same Audience of Performance A

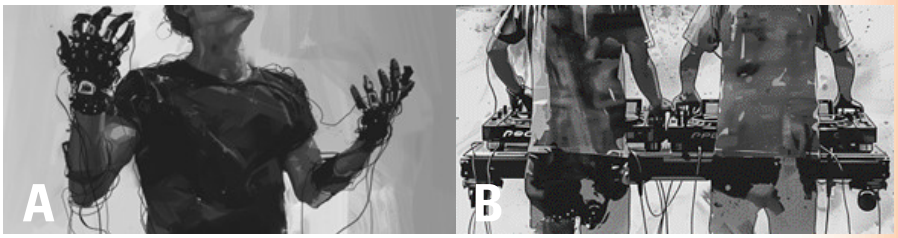


Fig.8. Performances A and B, respectively, live music performances, illustrated from field observation.

5.2 Social Survey on the Performances

For case study I, questionnaire results show Performance B has a higher overall score than A in all parameters (figure 7).

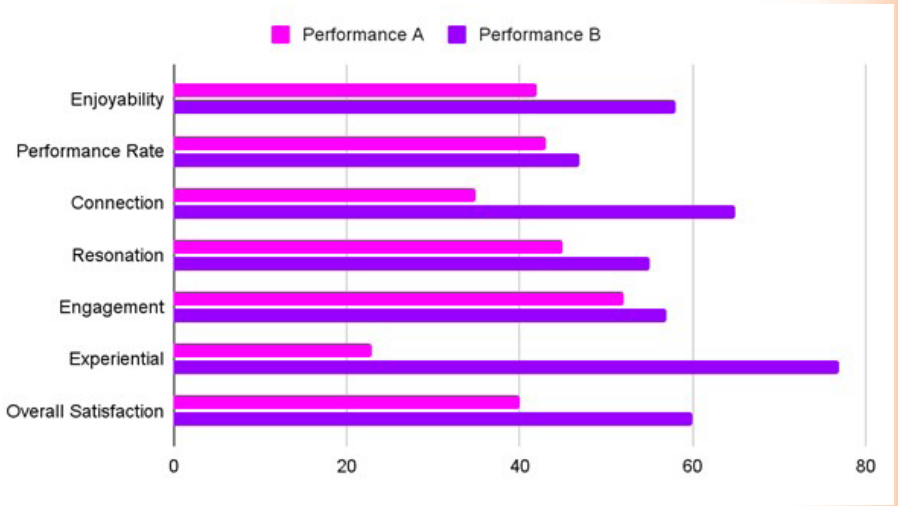
Upon closer examination, a critical disparity was observed: “experimental” and “connection” resulted in the greatest difference in audience scoring. However, the “performance rating” and “engagement” came close between the two shows.

Considering that Performance B included movement, while Performance A did not, it gave the audience a greater sense of connection to the performer. However, this feeling of connectedness does not necessarily affect audience engagement.

Although performer B’s music was not generated from precision, through spontaneity and free expression of bodily movement, it successfully aroused in the audience group a sense of exploratory excitement. Keep in mind that both performances enjoyed a similar level of quality regarded by the audience; B resulted in a significantly higher score in overall satisfaction.

This distinction rendered the performance with two focal points—sound and movement—where both elements assumed equal importance. Consequently, extreme expression or sensation, as emphasised in performance B, was heightened. It engendered heightened audience connection by adopting a curatorial-specific approach where movement and sound coalesce as subjects.

Here, the focus on movement, interactivity, and feedback exemplifies an immaterial approach and demonstrates the exceeding strength in building connections between subjects and agents. At the same time, the multi-modal art form provoked a sense of experimentativeness and satisfaction.



Graph 1. Survey results of case study I from thirty-two participants.

6. Comparative Case Study II: Space

6.1 Performative Architecture

Case study II was conducted on two spaces, X and Y, exhibited at Beams in London in 2023. All spaces were without performers; however, they showed a variety of research on sound, light, and space.

Space X specialises in real-time, generative, and code-based art, showcased through music, performances, and intricate installations. The objective was to elicit visceral and inspirational responses. By seamlessly merging noise with randomised algorithms, it harnessed digital technology to confront the political and power structures of the Anthropocene era, unveiling them as covert yet profoundly entrenched elements of contemporary society. Space X was a vast rectangular room, similar to a hangar, with a steel frame present every 3 - 5m. Connecting the frames are other steel beams, creating a grid. A continuous LED light source is linked with high sounds within each frame and beam. The light and sound moved together such that the volume and frequency of the sound changed with the brightness of the light. The darker and more intense the sound was, the more the light shaped the room.

Space Y, by Setup, is an internationally renowned studio that combines multimedia art, lighting and stage design, and performance programming. The team is motivated by its goal to investigate the expressive possibilities offered by emerging digital technology. Space Y also showed an interplay of lights and sounds where when one light is seen, a direct sound is associated with it. Its space was divided similarly to Space X. However, it was smaller than Space X.

Table 2. Summary of the comparison between the two spaces.

SPACE X	SPACE Y
Bigger space	Smaller space
Movement of LED Lights in straight lines	Movement of LED Lights in straight lines
Flashing of Thin light in grid location	No flashing of thin light
Flashing of Spotlight	No Flashing of Spotlights
High light strobe effect	No light strobe effect
Presences of Haze	No Haze
Presences of fans	No fans
Presence of speakers	Presences of speakers
Moment of emptiness	Low to no moments of emptiness

Fig.9. Space X and Y, exhibited in London, demonstrated different performative spaces with no performer.

6.2 Social Survey on Performative Architecture

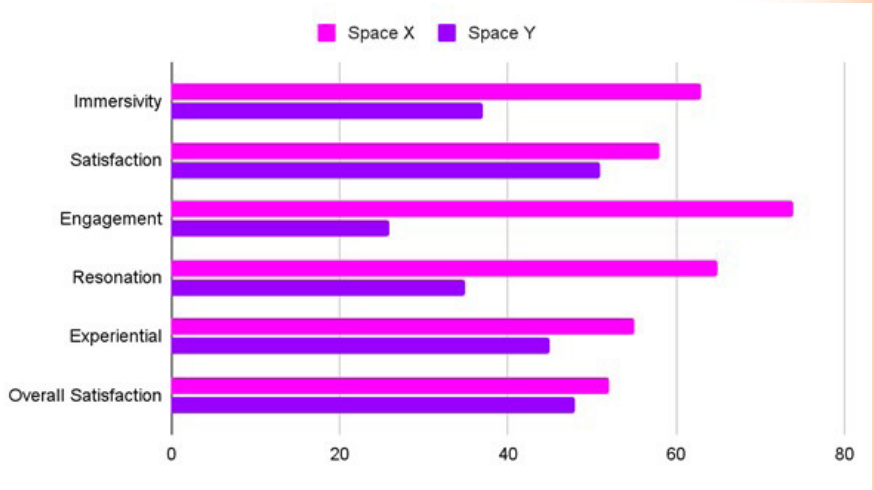
For case study II, Space X has a higher overall survey score than Y in all parameters (Figure 8). Space X exhibited differences in spatial manipulation, featuring more agents, such as light strobes, haze, and fans, resulting in a more pronounced lux effect and a more significant variation from darkness to light in a shorter duration.

By comparing the survey parameters, it can be observed that the most significant disparity in scoring between the two spaces resided in “engagement”. Both venues transformed the physical perception of space by integrating light, programming, and sculpture, creating an illusion of shifting boundaries and dimensions. However, the visual manipulation of space through extreme light and dark conditions in X fostered a perceptual shift in spatial proportions and form.

The second greatest disparity between the scoring of the two spaces lies in “resonation” and “immersivity”. A few differences could be evident when comparing the two design intentions. The immersive effect was accentuated in Space X by having more agents transition into subjects. A high light strobe effect dominated the space, with X having a vast ceiled space much more significant than Y. Also, X had moments of emptiness of light that weren’t as (in)visible in Y. Consequently, the perception of a shape-changing space in X contributed to a heightened resonation and immersive experience.

Despite the disparity in most parameters, the overall audience satisfaction came quite close between the two spaces. Also, both were regarded by most audiences as “experiential”. Noting that these venue designs involved an interplay of lights, sound and shadows, which fashioned the perception of dynamically changing spaces. The amalgamation of visual perception, auditory (a)synchronicity, and space operated harmoniously as a unified element.

These contributed to the space’s success in integrating subject removal and interactive elements approaches. Although the designs intentionally removed any human performer through automation to foreground architecture, it simultaneously reinforced human agency, as audiences who navigate between spaces, reflected and refracted by light and shadow, added to the theatrical presence. The navigation concurrently adds to the complexity of the rhythm and sound, orchestrating a spontaneous interaction and feedback between agents and space, resulting in high satisfaction of the performance.



Graph 2. Results Percentage of case study II from fifty participants.

7. A Proposal

7.1. Four Approaches to Performative Architecture

Based on the results and experience documented, four design strategies are formulated to create performative spaces to enhance audience experience and engagement.

Strategy 01: interactive elements: The design strategy for crafting a fully immersive performance space involves dynamically allowing the space to move alongside the performer. This approach is implemented by integrating sensors and actuators. Sensors detect the performer, while actuators facilitate the spatial adjustments. The technical intricacies of soft robotics can be explored through pneumatic or bending active structures like rods. Air compressors or a dynamical motor can manipulate these structures to effect the desired spatial transformations. Figure 11 depicts a diagrammatic example. The space exhibits particular behaviour at a specific distance from the performer and the sensors. If the distance exceeds a certain threshold, the sensors and actuators recalibrate to maintain proximity, allowing the space to move synchronously with the performer.

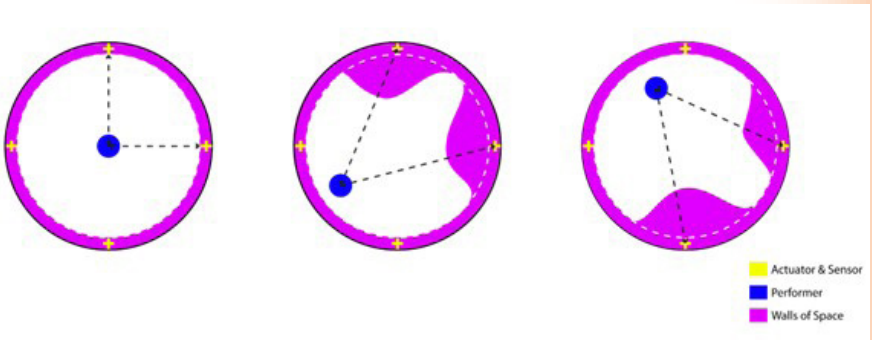


Fig. 10. Diagrammatic plan of strategy 01: interactive elements.

Strategy 02: subject removal: The second strategy involves accentuating the architecture by temporarily excluding the performer at specific intervals, redirecting attention to the architectural form and making it the focal point. Removing the performer puts the automation and controller of performative space in question, accomplished through a design approach that shifts the space from a monolithic structure to one with internal subdivisions. In such instances, the compartment can, at specific points, create situations where the performer is absent.

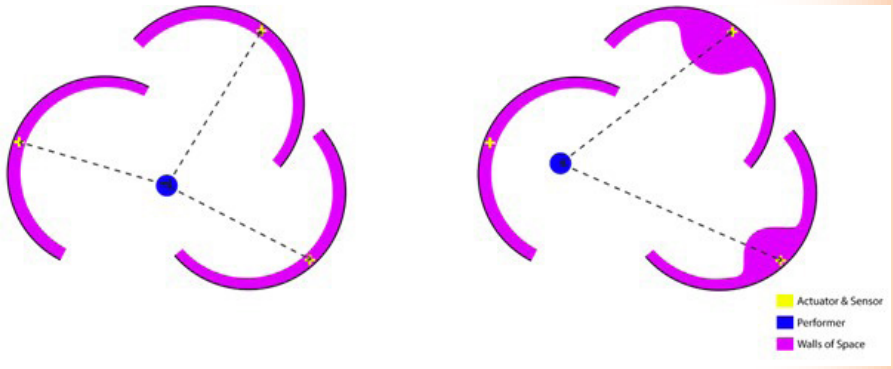


Fig. 11. Diagrammatic plan of strategy 02: subject removal.

Strategy 03: immaterial agents: For a more dynamic and curated experience, an approach involves drawing inspiration from museums and guiding participants through various spaces during a tour. This navigation simultaneously introduces the concept of multiple performing spaces, engendering excitement and anticipation through envelopes and discoveries, unifying spatial efforts to generate a progressive experience.

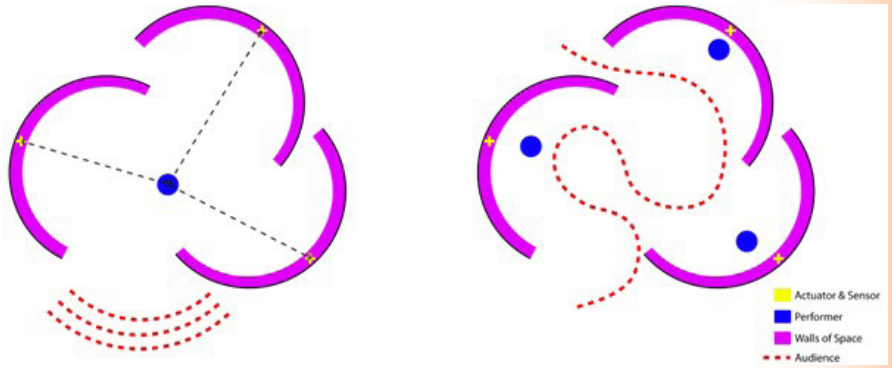


Fig. 12. Diagrammatic plan of strategy 03: immaterial agent.

Strategy 04: adaptive robotic system: The approach merges the spaces, creating an intermediary space between two performers. In this scenario, the intermediary space emerges as the focal point of architectural significance. It assumes the role of a performer within the spatial context. Figure 14 illustrates the convergence of these two spaces, giving rise to what we recognise as a full adaptive robotic system.

The interplay between architectural elements and the performer's presence in this space dynamically shifts focus. At times, the architectural design dominates the scene, drawing attention to its form, structure, and spatial qualities. Conversely, there are moments when the performer becomes the focal point, captivating the audience with their presence and actions within the space, assigning value to the spatial experience. By alternating between architectural prominence and performer engagement, the space is imbued with a sense of dynamism and narrative, inviting viewers to engage with it in a multifaceted manner.

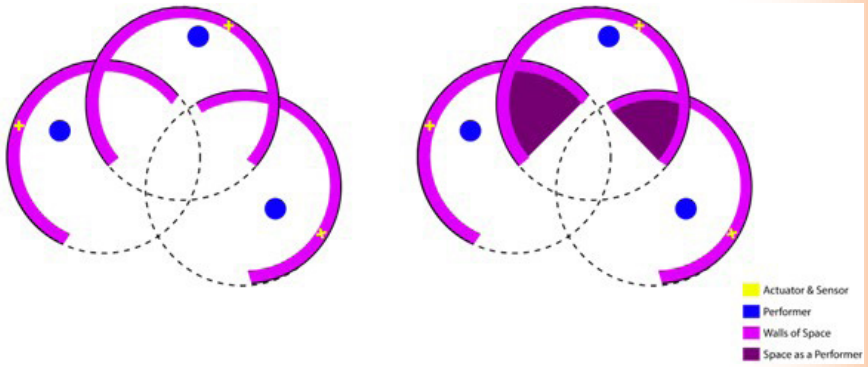


Fig. 13. Diagrammatic plan of strategy 04: adaptive robotic system.

7.2 Strategies Applied on a Merged Proposal *Soft Acoustic Tile* and *Interactive Pavilion*

We envision creating a pneumatic silicon space by fusing the design principles demonstrated in the material composition of the *Soft Acoustic Tile* and the inventive system employed in the *Interactive Pavilion*. This space is characterised by its dynamic inflation and movement towards

the performer once they surpass a defined distance threshold. Conversely, it deflates as it senses the performer's proximity to a designated pneumatic sensor. This synthesis introduces an architectural performer that seamlessly integrates with the theatrical performance, transforming into a technological extension of the dancer's movements. This symbiotic relationship between technology and performance enhances the immersive experience, blurring the boundaries between the physical space and the artistic expression.

The depicted sequence illustrates the conceptual framework of the initial strategy: Adaptive Robotic System. State 1 shows an unoccupied space, characterised by its inert state resulting from the absence of any activating force. Moving to state 2, a person is positioned within the space, strategically placed centrally at an equidistant specific distance from sensors A and B. Despite this arrangement, no inflation or activation is observed. However, in state 3, the performer shifted further away from the central point, causing sensor A to detect an increased distance. This alteration triggers the inflation mechanism, thereby instigating the activation of the space and demonstrating its responsive functionality.

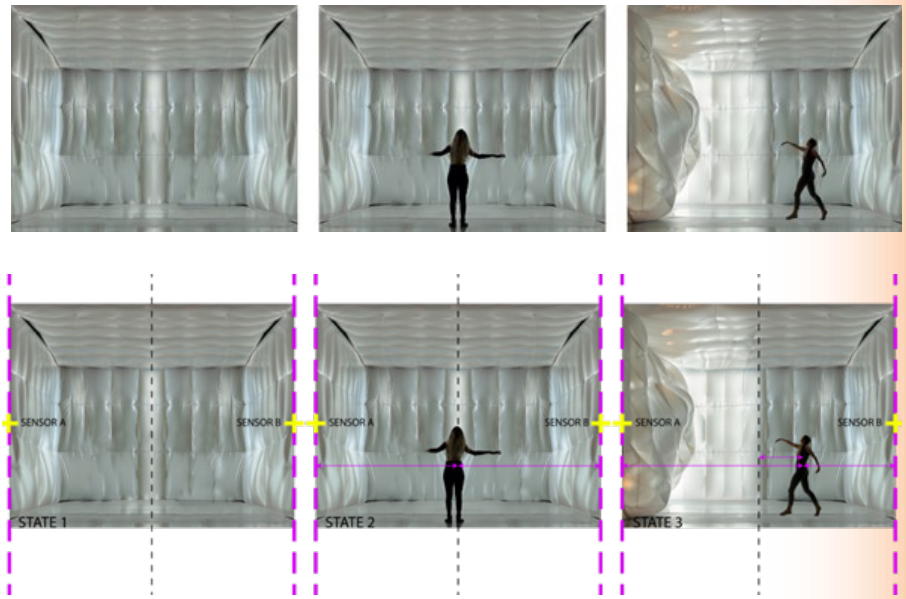


Fig. 14. Strategy 01 of the merged proposal showing three states.

The other strategy of having the space as a performer can be seen In figure 16, three distinct spaces are labelled A, B, and C. Both A and C contain performers, with B serving as an intermediary space where the walls shift in response to the movements in A and C. As individuals move away from the central space (resulting in increased distance between them and the sensor), the corresponding space expands proportionally to the detected distance. Hence, space B metamorphoses into an active performance area even in the absence of a performer within, thereby asserting itself as the foreground focal point.

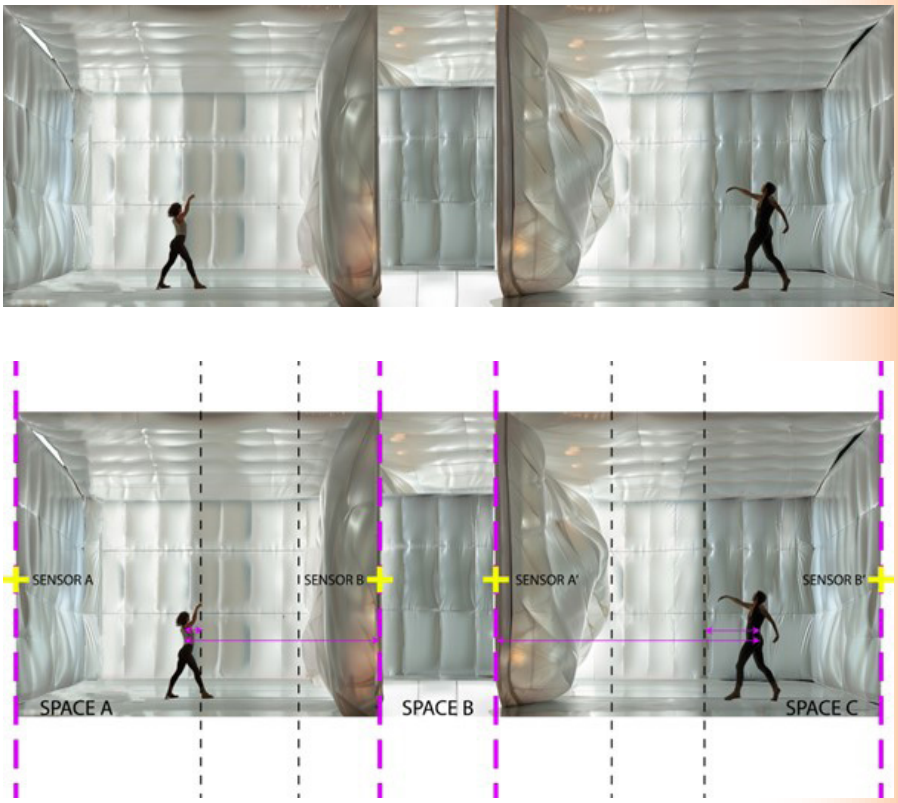


Fig. 15. Strategy 04 of the merged proposal.

8. Limitations and Next Steps

Upon reflection, the survey captured and agglomerated participants' experiences and perceptions; however, limitations were noted during the process.

First, potential response bias and the absence of open-ended questions for qualitative insights were noted. The study's next steps will be to conduct pre-testing and behavioural mapping validation to enhance reliability and triangulate results.

Second, questionnaires rely on self-reported responses, which may need more depth in exploring nuances to capture the spectrum of immersive experiences fully. The decision to begin with a formal survey approach was based on establishing a basic understanding. A future project iteration will involve informal responses from participants with a more participatory approach to cross-compare insights.

Third, a notable limitation is the need for demographic data collection. This step is vital for understanding the diversity of participants and gaining insights into how different social groups perceive and engage with performative spaces.

Finally, it is essential to note that with any dynamic performance, many variables beyond the architectural aspect contribute to the marvel. As these variables are often dependent and instrumental, it is essential to read the insights generated from the study as a reference for design aspiration.

The prospect of the four approaches guiding a systemic reading of performative space beyond stage design to the larger architectural realm is recognised. Still, applying them to experiment and progress

would need further effort. We hope this can lay the first foundation stones to provoke future work in the area.

9. Conclusion

This paper delves into the transformative potentials of integrating shape-changing soft robotic architecture into performance spaces. By endowing traditionally static architectural backdrops with dynamic capabilities, a new dimension of experiential design emerges, enriching the immersive journey for spectators.

This adaptability not only enhances the versatility of spaces but also lowers the marginal cost of mass customisation for individual performances. The infusion of dynamism can captivate and stimulate new bodily-sensory experiences and a deeper engagement with artistic narratives unfolding within material spaces.

As performance arts are increasingly challenged by growing digital engagement, behavioural change in audience habits post-pandemic, and a shrinking ticket market due to deflection, it calls for a paradigm shift in the way we curate, generate, and communicate the value of physicality.

Through a comprehensive analysis of four design approaches: subject removal, immaterial agents, interactive elements, and adaptive robotic systems, the study serves as a first step in uniting greater efforts, bridging dialogues, and sailing further expeditions on the shifting role of physical spaces in an increasingly digitised landscape.

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Appendix I

The following survey on case study I was asked:

1. Which performer's live electronic sounds did you find more enjoyable?

a. Performance A
b. Performance B

2. Rate your overall satisfaction with Performance A performance on a scale of 1 to 10.

3. Rate your overall satisfaction with Performance B on a scale of 1 to 10.

4. Which performer do you feel had a stronger connection with the audience during their live electronic performance?

a. Performance A
b. Performance B

5. Which performer's style of live electronic music resonated with you more?

a. Performance A
b. Performance B

6. How engaged were you with Performance A?

a. Not engaged at all
b. Somewhat engaged
c. Moderately engaged
d. Very engaged
e. Extremely engaged

7. How engaged were you with Performance B?

a. Not engaged at all
b. Somewhat engaged
c. Moderately engaged
d. Very engaged
e. Extremely engaged

8. Did you find Performance A more experimental or traditional?

a. Experiential
b. Traditional

9. Did you find Performance B more experimental or traditional?

a. Experiential
b. Traditional

10. Considering the overall experience, which performer's live electronic sounds left a stronger impression on you?

a. Performance A
b. Performance B

11. Which performer's live electronic performance resonated more with most of the audience?

a. Performance A
b. Performance B

Appendix II

The following survey on case study II was asked:

1. Which room did you find more immersive at Thin Air, Beams?

a. Space X
b. Space Y

2. Rate your overall satisfaction with Space X's performativity at Thin Air Beams on a scale of 1 to 10.

3. Rate your overall satisfaction with Space Y's performativity at Thin Air Beams on a scale of 1 to 10.

4. Which room do you feel had a more substantial impact on the audience?

a. Space X
b. Space Y

5. Which room resonated with you more?

a. Space X
b. Space Y

6. How engaged were you with Space X at Thin Air, Beams?

a. Not engaged at all.
b. Somewhat engaged.
c. Moderately engaged.
d. Very engaged
e. Extremely engaged.

7. How engaged were you with Space Y at Thin Air, Beams?

a. Not engaged at all.
b. Somewhat engaged.
c. Moderately engaged.
d. Very engaged
e. Extremely engaged.

Strange Undercurrents: A Critical Outlook on AI's Cultural Influence

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While generative artificial intelligence (generative AI) is being examined extensively, some issues it epitomizes call for more refined scrutiny and deeper contextualization. Besides the lack of nuanced understanding of art's continuously changing character in discussions about generative AI's cultural impact, one of the notably underexplored aspects is the conceptual and ideological substrate of AI science and industry whose attributes generative AI propagates by fostering the integration of diverse modes of AI-powered artmaking into the mainstream culture and economy. Taking the current turmoil around the generative AI as a pretext, this paper summarizes a broader study of AI's influence on art notions focusing on the confluence of certain foundational concepts in computer science and ideological vectors of the AI industry that transfer into art, culture, and society. This influence merges diverse and sometimes inconsistent but somehow coalescing philosophical premises, technical ideas, and political views, many of which have unfavourable overtones.

1. Introduction

With the 2022 release of popular online services and tools for text-to-image (TTI) synthesis, such as DALL·E, Leonardo, Midjourney, and Stable Diffusion, and the incorporation of diffusion model routines into offline software, generative artificial intelligence (generative AI) went mainstream. Featuring user-friendly interfaces and streamlined functionality, generative AI systems lowered the technical knowledge barriers for working with multimodal machine learning models that produce high-fidelity output, which expanded the AI's creative user base beyond tech-savvy artists, artistically inclined programmers, and researchers. Amateurs, hobbyists, and enthusiasts as well as professional artists and studios showcase, share, and monetize their generative AI-produced content on social media platforms and portfolio websites. They enter and sometimes win art competitions[1] (Roose 2022; Parshall 2023) and attempt to copyright their visuals (Appel et al. 2023), stirring an increasingly polarizing public debate about generative AI's economic, ethical, and legal consequences.

By composing prompts as keywords and model directives, a TTI user acts as a task definer and evaluator of the resulting images, and the AI system generates visual concepts and outputs the corresponding pixel arrangements.[2] The limitations of the existing TTI models make it hard to achieve the desired high-quality visual output, so prompting amounts to an iterative trial-and-error process. This expressive challenge to users' diverse notions of visual motifs, styles, mediums,

1. Examples include Jason Allen's image *Théâtre D'opéra Spatial* (2022, produced using Midjourney) which won in the digital category at the Colorado State Fair in 2022, and Boris Eldagsen's *Pseudomnesia: The Electrician* (2022, produced using DALLE2) which won the 2023 Sony World Photography Award.

2. For an overview of generative AI (multimodal generative models, diffusion models, and TTIs), see Radford et al. (2021), Ho et al. (2022), Ramesh et al. (2022), and Yang et al. (2022).

Keywords Art Notions, Artificial Intelligence, Computational Art, Computer Science, Generative AI.
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techniques, effects, and other common formal attributes has spurred a burgeoning online scene for sharing prompts, prompting techniques, and prompt-image pairs (on websites such as Prompt Hero) and trading them (on marketplaces such as PromptBase, Promptrr.io, Prompti AI, or PromptScoop).

Since they depend on a predictive amalgamation of styles and other features derived from digital samples of existing media (painting, drawing, photography, and text), TTIs (and generative AI systems more generally) are regarded as sophisticated remediation apparatuses related to, but distinct from style appropriation in postmodernist art and earlier remix cultures (Smith and Cook 2023, 2; Bolter 2023, 195–207).[3] However, despite TTI's disposal of a relatively diverse visual arts corpus, prompting practices largely privilege figurative and descriptive plastic motifs in popular genres of "surreal" or fantasy art, game art, comics, anime, or illustration, with a fixation on surface aesthetics and genre-specific stylistic norms at the expense of other important poetic factors (McCormack et al. 2024). This usage trend parallels the inevitable prevalence of cultural norms in generative AI's training datasets on account of which the TTI imagery often perpetuates and sometimes reinforces stereotypes, biases, and cultural hegemonies (McCormack et al. 2023). For all these reasons, the TTI scene can be considered as a conceptual antipode of art brut—art created by individuals operating beyond the official cultural boundaries (obscure amateurs, psychiatric patients, prisoners, etc.) and distinguished by its uninhibited freshness, non-compliance to expressive canons, and disregard of training-imposed conventions.[4]

While many researchers note that synthetic surface mimicry of popular visual styles does not constitute an artistic innovation and that, at this point, TTIs do not pose a serious threat to human art,[5] they are aggressively pitched as artistic tools. In a broader view, the AI industry's introduction of consumer-grade tools for artmaking and the popularization of other machine learning technologies (e.g. generative adversarial networks) for artistic purposes has never been an innocent or disinterested byproduct of AI's evolution. Releasing attractive devices for creative expression aids the AI industry's marketing, development, and public relations as widely adopted products become "indispensable", provide beta testing feedback and learning data from a large user base, and help associate AI with unique human faculties such as artmaking. The strategy has apparently worked well with the TTIs; uninhibited by the minuscule historical distance, the media, tech-pundits, and some scholars effuse about generative AI's disruptive power over and beyond art. For instance, Lev Manovich (2023) describes generative AI as a revolution comparable in magnitude to the adoption of linear perspective in Western visual arts and the invention of photography. Others believe that generative AI is a profoundly impactful medium whose "synthesis of human intuition and machine capabilities" represents a "paradigm shift" that "heralds a renaissance in artistic expression, offering glimpses into the limitless possibilities that lie ahead in this dynamically evolving art landscape" (Novaković and Guga 2024). They claim that generative AI transcends a mere artistic tool and makes a crucial step toward the fulfilment of the creative industries' long-standing goal to democratize creativity into a more socially integrated and economi-

3. See Butler (2003) and Navas et al. (2014).

4. The term art brut ("raw art" or "rough art") was introduced in the 1940s by French artist Jean Dubuffet.

5. See, for instance, Epstein et al. (2023), McCormack et al. (2023, 3), and Sanchez (2023).

cally productive force and thus redefine the "traditional exclusivity" of artistic roles (Kishor 2023).[6]

Conversely, authors such as Epstein et al. (2023), McCormack et al. (2023; 2024), Sanchez (2023), and contributors to Wilde et al. (2023), have identified and discussed a plethora of generative AI issues and fallouts, offering a more clearheaded approach. Generative AI's most salient problems include the legal and ethical concerns about online data use for model training (data laundering, copyrighted and non-consensual data acquisition, automated appropriation of developed artistic styles), biases (ethnic, racial, gender, cultural), modelling constraints (models as "cultural atoms"), the limitations of text-based paradigm for visual expression, the narrow levels of output and authorial control, the simplistic notions of style (in designing and using models), flimsy aesthetics (derivative visuals, conventionalization, homogenization), expressive novelty and poetic cogency inferior to other artmaking practices, systemic censorship, and short- and long-term impact on the creative and media industries (loss of human skills, job precarity, improved deepfaking, fake news).

The dynamic of opposing sentiments about TTIs' expressive capacities and limitations, as well as their sociopolitical and cultural issues, has turned generative AI into the word frequency star of critical AI studies. However, despite the scope and depth of their findings, critical AI studies largely resonate with academia, while the public and some segments of professional communities are being saturated with hyped-up rhetoric and generalized views that shape the prevailing art notions and directly or indirectly influence artistic practices in a range of fields. In such context, certain aspects of generative AI critique require more refined scrutiny and deeper contextualization. Notably, the discussion about AI's impact on art notions lacks a nuanced understanding of art's continuously changing identity brought about by the modernist avantgardes, postmodernism, and experimental art practices, which both reflects and retrenches the prevailing art dilettantism across the AI science/tech sector and affects the ways of pondering art's natures, functions, and futures. A related topic calling for keener attention is the conceptual and ideological substrate of the computer science and AI industry whose attributes generative AI helps disseminate by facilitating the proliferation of digital artefacts and fostering the integration of computational art into the mainstream culture and economy. In this paper, I focus on that haunting substrate.[7] It merges diverse and sometimes incongruous but somehow coalescing technical concepts, philosophical premises, and political views, many of which have the overtones of alienation, sociopathy, and misanthropy. They are largely obscured in the debates about AI's transformations of art and society and remain underexposed in AI studies so, in the closing section, I outline some of their manifestations in generative AI and introduce several viewpoints for a further critique of AI's cultural zeitgeist.

2. Undercurrents

A collection of tendencies and syndromes in the conceptual and ideological undertows of AI science, technology, and industry wields a strong if seemingly indirect influence on cultural mindsets and art notions. It includes the fetishism of machinic agency, the mutual equalization of computers and humans, statistical reductionism, sociotechnical blind-

6. Somewhat paradoxically, such enthusiastic claims tend to ignore the inherent temporal- and context-relativity (instability) of artistic traditions and thus the social porosity of artmaking professions.

7. The paper summarizes a part of the study that examines AI's influences on professional and popular art notions and critiques them within the perspective of the AI's often disturbing techno-cultural underpinnings.

ness, and cyberlibertarianism. Their disparity and, in some cases, apparent awkwardness notwithstanding, these factors amalgamate into a powerful flux.

2.1 The Fetishism of Machinic Agency

Although it ranks among the most widely and thoroughly discussed AI issues, anthropomorphism remains pervasive and highly detrimental to both AI science/tech and AI/art intersections. It is an innate psychological tendency to assign human cognitive traits, emotions, intentions, or behavioural features to non-human entities or phenomena (Hutson 2012). Exposing a trans-cultural anthropocentric tenet that humanity is the sine qua non of the universe (Tromble 2020, 5),[8] anthropomorphism has steadily pervaded the foundational concepts, terminology, and notions of intelligence in AI science and industry as well as in popular discourse (Salles et al. 2020). Its main aspects are encapsulated in David Watson's remarks (2019, 432, 434–435):

> *A number of [machine] learning algorithms either deliberately or coincidentally mirror certain aspects of human cognition to varying degrees. In a sense, this is only to be expected. For better or worse, we are our own best source of inspiration when it comes to modelling intelligence. There is nothing especially remarkable or problematic about this. However, issues arise when we begin to take these metaphors and analogies too literally. [...] Algorithms are not "just like us" and the temptation to pretend they are can have profound ethical consequences when they are deployed in high-risk and other sensitive domains. By anthropomorphizing a statistical model, we implicitly grant it a degree of agency that not only overstates its true abilities but robs us of our own autonomy. [...] Algorithms can only exercise their (artificial) agency as a result of a socially constructed context in which we have deliberately outsourced some task to the machine. [...] The central point—one as obvious as it is frequently overlooked—is that it is always humans who choose whether or not to abdicate this authority, to empower some piece of technology to intervene on our behalf. It would be a mistake to presume that this transfer of authority involves a simultaneous absolution of responsibility. [...] The temptation to grant algorithms decision-making authority in socially sensitive applications threatens to undermine our ability to hold powerful individuals and groups accountable for their technologically mediated actions.*

Anthropomorphism can be difficult to identify, especially in metaphors where it most frequently appears, which often has undesired consequences (Curry 2023, 178). As Kieran Browne and Ben Swift pointed out (2019, 3), in the language of AI, assertions that a machine "learned", "discovered", "outsmarted", etc. presuppose agency and often imply consciousness but even placing a machine as the subject of a sentence is dubious and deserves examination. The continuous illusionism of intelligent communication or "banal deception" throughout AI's history (Natale 2021) opens a perspective for understanding anthropomorphism and autonomous AI fetishism not just as the side-effects of our evolved bias toward detecting agency, but also in the light of human propensity for deception and self-deception (Trivers 2011).

Hence, it is often hard to evaluate, and easy to dismiss, the difference between the effectiveness of human intelligence and the efficiency

8. For instance, the narcissistic idea that sophisticated nonhuman entities (intelligent robots or angels) would strive to become human and gladly accept all the oddities and costs that come in the package underpins Isaac Asimov's novelette *The Bicentennial Man* (1976) and film *Wings of Desire* (1987, directed by Wim Wenders).

of specialized artificial processes related to our concepts of intelligence. Of course, there is no reason nor justification for conflating a non-living system with a biological entity just because both can exhibit some behaviours and perform certain functions that are computationally interpretable. Nevertheless, the media and some AI scientists repeatedly associate the performance of state-of-the-art machine learning systems with human cognitive traits such as intuitive physics, intuitive biology, intuitive psychology, causal models, active social learning, conceptualization, subconscious abstraction, generalization, analogy-making, and common-sense reasoning—the very capabilities they lack the most (Mitchel 2019, 140, 195–199). Throughout the history of computer science, the epistemological and metaphysical confusions caused by conflating human intelligence and machine performance have rendered anthropomorphism and AI inseparable, and some authors suggest that it is more feasible to manage anthropomorphism in AI research than purge it (Proudfoot 2011; Watson 2019, 417–440). In this light, we can view AI as an important part of techno-cultural and social dynamics in which a what becomes a who and vice versa (Bratton and Agüera y Arcas 2022). Its many problems arise from the awkward understanding of computers vis-à-vis human beings and paradoxical tendencies toward their mutual equalization reaching back to the foundations of computer science and AI.

2.2 Computers = Humans

One of the unfortunate consequences of Alan Turing's legacy is the intentional or accidental provision of a "scientific basis" for radical anthropomorphism—viewing and treating human beings as computers. In his paper *On Computable Numbers, With an Application to the Entscheidungsproblem*, Turing first described an "automatic machine", which was later named Turing machine and became one of the key concepts in computer science. The paper was published in 1936, before the advent of automatic computing, when many people in business, government, and research establishments professionally carried out numerical calculations. These human calculators were called "computers" and Turing reemphasized in various forms that the terms "computation" and "computable" in his paper refer to an idealized description of their work (Copeland 2020). Thus, Turing's analogizing of a set of highly structured operations performed by human beings with idealized computing machines makes sense only within the specific historical and utilitarian contexts of his writing. But he ostensibly went from connecting the isolated features of human and machine computation toward conflating human beings with computing machines. In a 1950 paper *Computing Machinery and Intelligence*, Turing proposed the Imitation Game as a method for testing a computational machine's ability to exhibit intelligent behaviour equivalent to, or indistinguishable from, a human. The proposal became known as the Turing Test, and this title has often been used to indicate other behavioural tests for the presence of mind or intelligence in artificial systems.[9] However, Turing cantered his proposal around an unclearly defined concept of intelligence and left many other parts of the discussion open to interpretation, which resulted in a long-lasting controversy (Oppy and Dowe 2020).

Strong objections to the Turing Test posit that with the Imitation Game Turing aimed to legitimize the "null hypothesis" of no behaviour-

9. Apocryphally related to a Victorian parlor game (Athanasius 2019), The Imitation Game involves a human evaluator who judges a natural language conversation between another human and a machine designed to generate human-like responses. Participants converse through a text-only channel (written messages) and the evaluator knows that one of the two conversationalists is a machine. The machine passes the test only if the evaluator cannot reliably distinguish between the machine's and human's messages after a fixed period.

al difference between certain machines and humans, and that such a perspective is arrogant and parochial because it assumes that we can understand human cognition without first obtaining a firm grasp of its basic principles (Searle 1980; Block 1981). Furthermore, assessing human intelligence through a single, highly formalized layer of linguistic communication (written text) is too narrow to be decisive as thinking is frequently nonverbal and combines verbal and nonverbal mental processes with numerous other factors (Tulio 2021). Turing's flirting with the "null hypothesis" also provides grounds for an argument that aloofness, narcissism, and psychological issues evident throughout his life "conspired" to elicit a misanthropic bitterness, which motivated the infantile computer-human analogy.[10]

The range, character, and persistence of grotesque notions in AI research indicate both conceptual and mental issues, so it is important to acknowledge their connotations and consequences:

> *The separation between "reasonable" and "unreasonable" ideas [in AI science], which we might call superstition is less clear than one might expect. In Computing Machinery and Intelligence, Alan Turing considers the use of a "telepathy-proof room" to protect the integrity of his Imitation Game from players exhibiting extrasensory perception. This may cause us to cringe in hindsight—it's uncomfortable to imagine heroes of science believing such unlikely things. But good science demands open-mindedness and the courage to challenge accepted truths. AI researchers are in a difficult position, expected to dismiss "silly" ideas like telepathy and yet take seriously the idea that bits of metal and silicon might become intelligent if you program them the right way. (Browne and Swift 2019, 2)*

Despite the intellectual challenges of cutting-edge thinking, the leniency in the AI community toward its founders' anthropomorphic tendencies[11] and its members' other quirks is regressive and irresponsible. The notion of personified computers awards the machine (a non-living entity) the role of the Other, places it into our circle of empathy (Singer 2011), and assigns it elevated rights while we have been long surrounded with living "candidates" for expanding our empathy or improving our ethics but still don't treat them consistently and justly: other human beings, animals, and plants. The consequently perverse logic of personified AI implies that we need to devise value systems (urgently needed but inadequately applied to many existing beings) on a purely speculative model of sentient AI.

How do such ambiguities translate to the reality in which the rapid industrialization and widespread application of AI technologies bring about the concentration of wealth and political power that leads to a society contingent on corporate AI interests?

2.3 The Autonomous AI Myth

Institutions and relations that involve frequent information exchange and processing can, for some practical purposes, be envisioned and treated as data structures. Thus, quantization, data collection, behavioural tracking, predictive modelling, and various types of decision-making manipulation have long been essential strategies for large-scale information-dependent systems such as governments, industry, marketing, finance, insurance, media, and advertising. The corporate

10. While acknowledging the caveats of retrospective diagnoses and the subjective nature of diagnosing in general, Henry O'Connell and Michael Fitzgerald's (2003) analysis of Turing's biography and contemporaneous accounts concludes that he met Gillberg, ICD-10, and DSM-IV criteria for Asperger's syndrome, which places him within the autism spectrum disorder.

11. Another pioneering giant of computer science and AI, Marvin Minsky, was a proponent of the concept of a computer as a person (see Elis 2014). Jaron Lanier's autobiography *Dawn of the New Everything* (2017) provides several vivid accounts that illustrate the prevalence of such a mindset among Silicon Valley hackers.

AI sector increases the extent and intricacy of these strategies by combining massive digital datafication with sophisticated statistical algorithms for profiteering or social engineering, which has many undesirable effects (O'Neil 2016; Zuboff 2019). Statistical reductionism is not exclusive to businesses and can be radicalized by state regimes that deploy AI for authoritarian societal control and governance. For instance, the Social Credit System and the "innovative development pilot zones", implemented by the Chinese government and AI industry in 2014 and 2019 respectively, are based on a state-wide networked surveillance and assessment of citizens' social and business activities with practical repercussions such as the availability of jobs, education, bank loans, electronic services, transportation, and travel (Yang 2022).

While promising improved discovery outcomes in science, increased economic productivity, commodity spectrums, and profits, the AI industry generates problems that affect various demographic groups. They mostly arise from the disparities between its business priorities (maximizing profit/wealth and competitive power), the social impact of its products, and broader societal interests. Since Google's data harvesting operations that started in the mid-2000s and ImageNet's popularization of image scraping practices in the mid-2010s, modern AI development rides a razor-thin line between research and commerce, and the AI industry often abuses it. Programmatically collecting vast amounts of data and using questionable labour practices to assemble it into the model-training datasets (public or private) is ethically dubious, even in the academic context. However, once the economy springs up around such practices, they become harder to control and regulate.

In aggregate, these trends contribute to an illusion that human-created and human-dependent AI systems have high levels of material abstraction and functional autonomy. Pervading both professional and public discourse, the myth of autonomous AI continues the tradition of using human beings as hidden micro-components in large computational architectures since the late 19th century. It has been identified as AI's "sociotechnical blindness" (Johnson and Verdicchio 2017), "fauxtomation" (Taylor 2018), "ghost work" (Gray and Suri 2019), and "human in the loop" complex (Paulsen 2020). The "synergy" of human work extraction and transparency is notoriously evident on largely unregulated online marketplaces for crowdsourced labour (also called microlabour or crowdlabour).[12] A plethora of unethical HR management practices and widespread workforce exploitation on microlabour platforms through a combination of technical features and legal loopholes has been thoroughly documented (Irani and Silberman 2013; Lorusso 2020; Zukalova 2020). With generative AI, algorithmized human labour demands have somewhat changed from their role in trailblazing AI development techniques and pipelines (Williams et al. 2022), but remain enormous and exploitative: many essential tasks are repetitive and meaningless, and labour conditions are precarious and surveilled (Dzieza 2023; Solaiman et al. 2023; GlobalData 2023).

12. Since its launch in 2005, Amazon's Mechanical Turk has been the largest and most widely known microlabour platform (Mitchell 2019, 84–85). Other platforms include Fiverr, Microworkers, Clickworker, Upwork, TaskRabbit, WorkMarket, Catalant Technologies, Inc., and Toloka.

2.4 Cyberlibertarianism

Constructing elaborate illusions of autonomous automation and designing labour maximization algorithms are certainly not AI's most impressive achievements but are emblematic of corporate AI's social politics (Crawford 2021, 48–49, 53–87).[13] Since the mid-1960s, the worldviews in computer science communities and IT industries, particularly in the US and other anglophone countries, have been shaped by a bizarre ideological conglomerate of contradictory doctrines, such as utopianism, counterculture, individualism, libertarianism, and neoliberal economics (Turner 2008; Gere 2008; Rushkoff 2022). This ideological assemblage, also called the Californian ideology (Barbrook and Cameron 2008) and cyberlibertarianism (Winner 1997), comprises ideas fuelled by the zeal for technologically mediated lifestyles and future visions with libertarian notions of freedom, social life, economics, and politics. It promotes technological determinism, radical individualism, a deregulated market economy, trust in the power of business, and disdain for the role of government. These values fully make sense only within the context of the right-wing political milieu (Payne 2013; Armistead 2016) and, openly or tacitly, many cyberlibertarians endorse the unblushing egoism promoted by Ayn Rand's dilettante philosophy (Objectivism) but conveniently overlook its bleak sociopathy (McGinnis 2012; Robephiles 2022), sometimes with the overt cynicism of providing the "philosophical authority" for socioeconomic views steeped in technocracy, greed, and exploitation.[14]

Cyberlibertarian tendency to conflate social and political with technical problems can be summarized in the three assumptions of technological manifest destiny: 1. technology is apolitical so it will automatically lead to good outcomes for everyone; 2. new technologies should be deployed as quickly as possible, even with incomplete knowledge about their functioning and societal impacts; 3. the past is generally uninteresting and history has nothing to teach us (Mickens 2018). After the introduction of blockchain technologies in the late 2000s, the cyberlibertarian techno-solutionist politics has been radicalized by the burgeoning start-up mentalities of predominantly white male crypto entrepreneurs obsessed with quick success and tending toward sexism, racism, misogyny, homophobia, and transphobia (UNESCO 2020). Cyberlibertarianism thrives behind the AI industry's facade of objectivity, rationality, progress, and political correctness whereas its reality is dominated by aggressive competitiveness within an adversarial business culture that promotes the most unpardonable tenet of capitalism: prioritizing profit over people (Wiener 2020). AI industry values "uniquely human" skills such as attention, care, critical judgment, taste, imagination, improvisation, spontaneity, sincerity, empathy, intimacy, and humour not because they evidence individuality or authenticity but primarily because they cannot be automated for generating surplus value (Horning 2015; Gosse 2020). In that context, generative AI can be seen as the forefront of the reiterative entrepreneurial process toward emancipating capital from humanity (Dyer-Witheford et al. 2019, 7), in which human work and data provision build systems that automate certain tasks and reconfigure human working and data provision roles in the next iteration.

While some authors deem such logic morally untenable and AI's labour displacement effects destructive in the long term (Eubanks 2018) and others remain undecided (Epstein et al. 2023, 8–11) or claim the

13. It is not clear whether or how significantly modern AI's social politics has diverged from the foundational principles of cybernetics in the 1950s and 1960s. In an anticipation of computers thoroughly integrated into human affairs, cybernetics founder Norbert Wiener (1988) criticized control-hungry sciences and technologies of the past and (arguably) strived to empower society by the humane application of bio-inspired, self-regulating artificial systems. However, authors such as Donna Haraway (2016) and Andreas Broeckmann (2016, 113–115, and passim) claim that the technological and biopolitical paradigm of cybernetics related humans to machines ambiguously and was ideologically geared at subjecting humans.

14. For a substantial critique of Rand, see the RationalWiki article (2023).

opposite (Kalish and Wolf 2023), it is worth remembering that, insofar as we take advantage of AI's sociotechnical regime, we share a degree of responsibility for its existence and consequences. This entanglement is evident in the ethical inconsistencies of some leading critics of cyber-libertarianism who selectively enjoy certain layers of its gravy train by patronizing convenient businesses that epitomize the most acute points of their critique, which may be interpreted as unprincipled or hypocritical. For instance, authors such as Shoshana Zuboff, David Golumbia, and Paris Marx choose publishers who sell their books on Amazon.com[15] rather than less lucrative alternatives, such as the Institute of Network Cultures (INC), which allows readers to either purchase INC books on their website or download them for free.

3. Conclusion

Although the historical, philosophical, and sociological studies of computer science and AI have explored most of these issues, they require wider attention in artistic communities because the AI industry's instrumentalization of art and creative expression for the promotion of its products serves as one of the high-bandwidth channels for the cultural normalization of questionable presumptions, concepts, economic interests, and political views in its background. The confluence of AI's problematic undercurrents hijacks our cultural intuition (Pedwell 2022), translates into art practices and their public reception (Lossin 2022), and influences the notions of art and creativity in the professional and popular art discourse.

For instance, the claims of generative AI's Promethean role in "democratizing artmaking" reverberate the cyberlibertarian myths about the democratizing powers of markets and digital technologies (Golumbia 2016). They also support the info-capitalist exploitation of creativity (Reckwitz 2017). Anthropomorphism in AI art, its media representation, and public interpretation articulate motives for relegating creative decision-making to AI systems, hedging or minimizing artistic responsibilities, and foregrounding the benefits of automated cultural production (Browne 2022). The resulting notions of art made by autonomous AI entities reinforce the AI industry's sociotechnical blindness. Users' compliance with generative models' censorship criteria (Riccio et al. 2022) upholds the AI industry's confinement of clients' socioeconomic benefits from leveraging its products. Similarly, artists' apparently sensible adoption of first-aid tech solutions against the misappropriation of their work for generative models training, such as data poisoning or style masking (Shan et al. 2023), inadvertently plays in tune with the techno-solutionist rhetoric whereby only the tech (but not the regulation of techno-economic power) can save us (Morozov 2013) and diminishes the vitality of art as a human faculty. AI's troubles get additionally legitimized through the tech science and industry's implicit sanctioning of their creative employees' relational deficiencies and psychological disorders as acceptable trade-offs of otherwise desirable talents (Dayan 2017; Wayne Meade et al. 2018) and through the corporate "justification" of sociopathic entrepreneurs due to the successes of their daring but morally dubious business ventures (Jacoby 2020; Marx 2023).

The sinister undertows of AI-influenced culture can be critiqued further as an amalgamation of economic interests (Golumbia 2009), self-indulgent anthropocentrism (Zeilinger 2021), psychological mech-

15. Golumbia also monetizes his essays behind the paywall on Medium (founded by Evan Williams, a tech billionaire, co-founder, and former CEO of Twitter), while Marx hosts his podcast Tech Won't Save Us on YouTube and monetizes it through Patreon.

anisms of self-deception and cognitive compartmentalization (Trivers 2011), as well as virtue-signalling, competitiveness, and exploitative drives (Miller 2019). The fact that shady motives and unflattering features of human nature remain insufficiently considered in AI studies may help explain the ease with which (mis)anthropic contradictions infuse the artworld's and popular notions about artmaking, sometimes with detrimental effects (Grba 2022; 2023). In this paper, I sketched the main aspects of AI's disturbing undercurrents aiming to expand the repertoire of viewpoints for appraising art and creativity in the age of AI. By looking critically into the mise-en-scène of AI's cultural sway, we can cultivate an informed and responsible approach that adds a touch of scepticism when asking how profoundly technological trends, such as generative AI, transform our relationships with art and in which directions they stir the arts' social, economic, and political roles.

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Media Language and the Technological Imaginary

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Writing in digital and computational technological conditions is by and large an input upon surfaces. It aligns with media, technologies, and techniques in its environment. This conditions us to understand writing and its literary aspects in a material process. This paper proposes to understand writing by examining the concept of media language. Media language suggests a new way of grasping writing via reading its structure of textuality. In this paper, this media language is developed in relation to a material-linguistic process of thinking and using technology, through synthesizing aspects of Eastern philosophy and Walter Benjamin's theory. As a basic element of media language, positional notation shows the meaning production of media language lies in how it resonates and weighs within its labor activities of reading, writing and language act. Technological imaginary further offers a becoming of writing via body technics by Deleuze. Media language in its technological imaginary allows literary study to be conceived as a dynamic analysis of material and literary forces.

1. Literary Device

With the development of new media technologies, scholarship on writing in literary and media theory has underscored writing's literary materiality (Hayles 2002; Kirschenbaum 2016). These discussions reveal new characteristics of writing under digital technological conditions, shaping the fields of electronic literature, digital language arts, and digital studies. Writing is a cultural technique of artificial flatness (Krämer 2022; 2003), a technology with visuality and spatiality (Liu 2006); that occurs within textual laminate in computation (Tenen 2017), and we understand writing by its language act that incorporates reading (Cayley 2018). For Bernard Stiegler, writing is a mnemotechnic that inevitably exteriorizes itself as a systematization of memory for storage (2010). He also criticizes Derrida's concept of deconstruction for making it difficult to distinguish between the different media technocultures such as writing and image (Derrida and Stiegler 2002). Following this line of thinking, this paper asks if there is an idea that conceives writing not only as a medium, technology or cultural technique, but an entity that can mobilize media, technologies and cultural techniques, and work together for the autonomy of writing. The exteriorization of writing inevitably pushes writing into an instrumentalized position, while the autonomy of writing in this paper addresses how writing becomes in a creative fashion.

Writing in digital and computational technological conditions is by and large an input upon surfaces. Acts of reading and writing happen in both computation and human-machine interaction. As media phi-

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losopher Sybille Krämer notes, inscribed surface can be understood as a mediator between one-dimensional time and three-dimensional space within artificial flatness (Krämer 2022, 89). Writing in this sense becomes operative at the dimensions of the inscribed entities. Moreover, the operative writing also suggests a material process of writing, in which literary aspects of writing, such as reading, text, and language, work together to realize the autonomy of writing.

Literary critic Rita Felski comments on literary studies and actor-network theory by sociologist Bruno Latour, suggesting a materialist view on literature. According to Felski, literary work can be seen as an actor knotted into forms of association that help make things happen (2015, 739). Our entanglement with text is a precondition for forging further interpretation and perception that account for why these texts matter. This process of text as a nonhuman actor moves across time and space. Following this idea, the paper develops the concept of media language as a material process of time-space operation. Specifically, media language is a way of grasping writing via reading its structure of textuality. It is first of all constituted by language acts that incorporate reading and writing, as John Cayley defines language act as a way of experiencing language via reading, "a symptom of our 'having' language" (2018, 2). With acts of reading and writing, media language constructs a structure of textuality to differ and defer the material process of writing. In this paper, how media language constructs structure of textuality will be developed. Before doing so, the paper articulates a media aesthetic of knowing and feeling the material process of writing. In this process, media language can be understood as a process supported by material and labor activities that mobilizes a dynamic of literary forces.

Intwined with the conception of media language, the paper examines the condition in which media language mobilizes a dynamic of literary forces through the notion of technological imaginary. Aspects of Eastern philosophy introduced in this paper and Gilles Deleuze's terminology of body technic offer a way of thinking about the exteriorization and interiorization of writing in its technological material process. This technological imaginary grounds media language in a becoming of writing, conditioning a material-processual structure of textuality that differs and defers writing. Media language and the technological imaginary can be considered as a preliminary step of materializing literary study to be an analysis of dynamics, allowing us to further think how literary device engage with social and political machines.

2 Bearing and Resonating: A Media Aesthetics

> *The story comes from China, and tells of an old painter who invited friends to see his newest picture. This picture showed a park and a narrow footpath that ran along a stream and through a grove of trees, culminating at the door of a little cottage in the background. When the painter's friends, however, looked around for the painter, they saw that he was gone—that he was in the picture. There, he followed the little path that led to the door, paused before it quite still, turned, smiled, and disappeared through the narrow opening. In the same way, I too, when occupied with my paintpots and*

> *brushes, would be suddenly displaced into the picture. I would resemble the porcelain which I had entered in a cloud of colors (Benjamin 2006, 134–35).*

Walter Benjamin once had this experience of appreciating a Chinese painting. Together with his thoughts on astrology, language, and mimetic faculty, they exemplify how resonance happens in a media language. To unpack Benjamin's experience, it is first necessary to expand the notion of correlation in relation to ancient Chinese thought that is much discussed by sinologists. Correlation offers a lens of thinking about resonance, which can be conceived as a way of knowing and feeling the material process of writing.

"Correlative thinking" was introduced by French sinologist and sociologist Marcel Granet. According to him, the Chinese way of perceiving and thinking is particular and concrete, rather than abstract and analytic. The Chinese language often uses a pattern of correlation and is expressed in the form of parallelism. It lacks grammatical forms that express the idea of causality or logical ideas (Harbsmeier 1998, 22–23). British biochemist, historian of science and sinologist Joseph Needham followed this line of thought so as to discuss the correlative thinking in specific "symbolic correlation" in Chinese cosmology. According to him,

> *In correlative thinking, conceptions are not subsumed under one another, but placed side by side in a pattern, and things influence one another not by acts of mechanical causation, but by a kind of 'inductance'. ... The symbolic correlations or correspondences all formed part of one colossal pattern. Things behaved in particular ways not necessarily because of prior actions or impulsions of other things, but because their position in the ever-moving cyclical universe was such that they were endowed with intrinsic nature which made that behavior inevitable for them. If they did not behave in those particular ways they would lose their relational positions in the whole (which made them what they were), and turn into something other than themselves. They were parts in existential dependence upon the whole world-organism. And they reacted upon one another not so much by mechanical impulsion or causation as by a kind of mysterious resonance (Needham 1956, 281).*

In subsequent discussions on correlative thinking, arguments often contest this alogical or pre-logical viewpoint: correlative thinking is pre-logical and pre-linguistic in that its aesthetic ordering is based on imaginative association and spontaneous correlation. It is beyond logical analysis and rational communication, meaning that correlative and analytic thinking are not incommensurable. Contemporary philosopher Fung Yiu-Ming argues that "thinking in correlation or association is not other thinking than the analytic kind; it is just the rational thinking in correlation or association" (2010, 304).

Correlative thinking suggests an organismic and holistic view of resonance. Resonance, *i.e. ganying* (literally feeling and response, 感应), is a notion describing a sensibility beyond five senses. It is a cosmological principle of stimulus and response throughout the force of qi (vital force, 气). The existence of resonance rests upon "the presupposition of unification between the human and the Heaven", it implies "a homogeneity in all beings" and "an organicity of the relation between part and part, and between part and whole" (Hui 2016, 27–28). Instead of following the organismic and holistic presupposition of resonance, the paper

intends to show a more nuanced understanding of resonance deriving from ancient Chinese aesthetics. My concern about resonance lies in how correlative thinking works in a media language via the structure of textuality.

Drawing from the Aristotelian tradition of mimesis, Benjamin situates mimesis not as an imitation of nature, but as an irreducible, material element of nature itself. The sensuous similarity in nature stimulates and awakens, then passes over into a historical human experience with non-sensuous similarity. Language in the middle is "a medium into which the earlier powers of mimetic production and comprehension have passed without residue" (Benjamin 1979b, 163). In discussing the doctrine of the similar, Benjamin uses an example of astrology to show how the mimetic faculty is an adaptive force of cosmological being, manifest in a transitional moment of language. Astrology speaks of a similarity which exists between a constellation of stars and a human being. Language in the middle bears an "instantaneous flash" bound within the perception of similarity (Benjamin 1979a, 66). For Benjamin, language is an archive of non-sensuous similarities, of non-sensuous correspondences; "the coherence of words or sentences is the bearer through which, like a flash, similarity appears" (Benjamin 1979b, 162).

The similarity Benjamin discusses can explain correlative thinking, in the way that its language is medial and communicates the being and becoming of mental entities. This link between similarity and correlative thinking comes from my contemplation of Benjamin's own experience of the story of Chinese painting shown at the beginning of this section. In the story, media language is at work for both the painter and Benjamin. The media language firstly makes the painter and the picture communicable. The painter and his movement into the picture constitute a becoming-picture in language itself. Secondly, Benjamin mimicked the media language by responding to his mental becoming as a linguistic becoming towards the material process of being in color. Here, the media language itself is a mental becoming that is communicable. As Benjamin noted, the mimetic element in language is like a flame: it manifests only through a kind of bearer. "This bearer is the semiotic element" (1979b, 162).

The resonance of media language also lies in a "leaving blankness" (liubai, 留白), which is a painting technique relating to *ganying* in Chinese aesthetics. In a traditional Chinese landscape ink painting (shanshui hua, 山水画), leaving blankness is a common painting technique that helps painters not only structure the space of painting but also perform an aesthetic effect that centers on the motif of nothingness. Leaving blankness means the lack of substance because it allows the vital force qi to run through "ten thousand things (wanwu, 万物)" of nature and renders it into a formless fluid that morphs into various forms; it is both the producer and the catalyst of relations (Yu 2016, 102–3). In the above case of the media language of the painter, the painter "followed the little path that led to the door, paused before it quite still, turned, smiled, and disappeared through the narrow opening" (Benjamin 2006, 162). This movement itself becomes a language act: while the becoming-picture of the media language does not mean an objectification of the painting subject. Instead, the language act reveals and bears the relational materialities of the painting through the movement that is empty and contains nothingness. Similarly, Benjamin detached and dissolved himself in the media language of becoming-color. Resonance

happens as vital force running through the media language of becoming-color.

The bearing and resonance of media language produce meaning through vital forces among relational materialities, it therefore indicates that labor activities support the material process of writing. In computational conditions, these labor activities and vital forces realize the materiality and processuality of writing via the structure of textuality.

3. Structure of Textuality

Printer Prosthetic: *Futura* (2017) is an experimental reprinting project of a collection of concrete poetry *Futura* (1965-1968) by conceptual artist, editor, publisher, and printer Hansjörg Mayer. New York-based artists Federico Pérez Villoro and Christopher Hamamoto adapted a home printer HP DeskJet 1112 by attaching a device that interacts with the printer's encoder strip, a plastic or mylar length of material that communicates with the print cartridge (see Figure 1 below). The device is made up of a set of Arduino hardware and software. Arduino is an open-source hardware and software platform that designs and manufactures single-board microcontroller kits for building digital devices. It connects code to the prosthetic board that is attached to the printer. "Once the prosthetic is on, the printer arm will move back and forth. The rate at which the motor will move and how far the arm will extend, is dependent on the Arduino code, the gear's size and their number of sprockets" (Villoro and Hamamoto 2017, 19). In addition, the Arduino code can activate a light sensor. The intensity of light on the sensor will act as a variable in determining the arm's environment. For example, the work *Futura 19* is entitled *Chamber Music*, originally written by Bob Cobbing in 1967. Its reprinting version is defined with these parameters: 1 second interval; ambient light; rotate 45°; standard movement length; standard motor speed; standard gearset (Villoro and Hamamoto 2017, 29).

Fig.1 The apparatus of a printer and its prosthetic device of Arduino hardware and software for producing *Printer Prosthetic: Futura*. Photo from Printed Matter. (https://www.printedmatter.org/catalog/48601/)

The code and its programmable language in this case determines the process and output of reprinting. It also defines every act of writing and reading, no matter analogue or digital one. For instance, the pro-

gramming language reads button states (if switching on/off) after digital writing that defines high/low voltage. In this case, this programming language is a script of a set of material languages, which includes the operation of button, the work of motor and gear, the circulation of electric current, the mobilization of the prosthetic to relevant parts of printer, etc. Therefore, the printed paper bears these language acts. The notion of language act comes from Cayley. He defines language act as a way of experiencing language via reading, "a symptom of our 'having' language" (Cayley 2018, 2). In the case of the printer prosthetic, language acts become automated in that writing and reading are programmed, meaning computation initiates and drives the work of material languages.

In the case of the concrete poetry *Futura 19*, words on printed paper gain their weights by containing different notational materialities. The words are first of all signs and symbolic in their original concrete poetry. They are at the same time data in the machine complex of the printer prothesis. They also relate to codes that define parameters and condition writing. With these features, the words become positional notation in that their place value produces meaning. To be specific, when reading the concrete poetry *Futura 19* on printed paper, the reader needs to recognize the varied notational materialities of words, suggesting reading a structural process of textuality made by instructions of parameters such as interval, light, rotation, movement length, motor speed, and gearset. The notational materialities constitute the material processuality of language acts, allowing computation to initiate and drive material language. The structure of textuality constitutes the media specificity of language acts, mediating between programming language, material language, and natural language.

As discussed earlier, acts of writing and reading become automated in the computation of the printer prosthetic, meaning language acts are a part of programming language that drives the work of material language. Media language in the middle of this process enables us to recognize the notational materialities of a word and its structure of textuality (constituted by its roles as symbol, data, and code), where a word as a positional notation produces meaning. This positional notation and its place value also alter the meaning of "concrete" poetry. The positional notation suggests a structural process of textuality made by notational materialities of a word, which encompass instructions of parameters such as interval, light, rotation, movement length, motor speed, and gearset. These characteristics and agencies of a word weight up the place value of a positional notation, meaning the positional notation bears the weight of notational materialities in paperspace. The notion of paperspace comes from James Joyce. In *Finnegan's Wake*, he identifies the material arrangement of word, letter, penstroke as such on paper as the signature of paper itself (Joyce 2012, 115). Joyce's paperspace used here is to address how positional notation on printed paper turns the piece of paper into a paperspace where notational materialities gain weight to the positional notation.

In the case *Printer Prosthetic*, notational materialities that encompass the attributes of data, word, and sign require the reader to read a structural process of textuality, meaning not merely having a literary reading of a poem on printed paper, but also a legible and literal reading of material language driven by data and program. This indicates that instructions of parameter initiate and drive material energies of the writing apparatus, which are constituted by interval, light, rotation,

movement length, motor speed, and gearset. In this sense, the positional notation bears such a media language. Its place value lies in relational materialities of notations (data, word, sign), which allow multiple notations to resonate.

The bearing and resonance of media language offers a way of understanding technology through the material energies it conveys, manipulates, and transforms. It in turn redefines technology. Relating to writing, aspects of Deleuze's theory of technology enables us to consider writing in relation to the fact that body conveys varied forms of life that goes beyond organ and embodiment, something assembles sensibility and intelligibility within media language. This bearing of media language also allows us to consider media language itself is constitutive of body technics that allows technological imaginary to happen. The technological imaginary means a new way of reading the technology, cultural techniques, and media of writing through constructing the structural process of textuality. The technological imaginary conceives the notion of prothesis as an autonomous agency in engendering writing.

4. "Body" Technics on Surface/Interface

Cucumber slices
The juice runs
Drawing spider legs

After his trips to Japan between 1966 and 1970, Roland Barthes depicted Japan as a "fictive nation", a "novelistic object" in his book *Empire of Signs* (1982, 3). Japan is fictive and novelistic in that, Barthes wants to explore it as "the possibility of a difference, of a mutation, of a revolution in the propriety of symbolic systems", instead of another symbol, another metaphysics simply taken as the Orient and Occident (Barthes 1982, 3–4). Like the Haiku above, Barthes reads it as a pursuit of the essence of smallness when eating: things are small to be eaten, are also comestible to fulfil smallness. When describing this smallness, Barthes found an operative language of chopsticks:

> *First of all, a chopstick—as its shape sufficiently indicates—has a deictic function: it points to the food, designates the fragment, brings into existence by the very gesture of choice, which is the index; but thereby, instead of ingestion following a kind of mechanical sequence, in which one would be limited to swallowing little by little the parts of one and the same dish, the chopstick, designating what it selects (and thus selecting there and then this and not that), introduces into the use of food not an order but a caprice, a certain indolence: in any case, an intelligent and no longer mechanical operation. (Barthes 1982, 16)*

Comparing with knives and forks, a pair of chopsticks as an instrument "never pierces, cuts, or slits, never wounds but only selects, turns, shifts", it thus *transfers* food (Barthes 1982, 16, 18). This reflection on chopsticks in a way suggests technology and technique compose an operative language between the eater and food. Accordingly, it also suggests a different way of knowing and using technology from the West, which

can be reflected in aspects of the philosophy of Japanese philosopher Watsuji Tetsou.

In a philosophical study of climate, Watsuji indicates that climate is an outside agency that initiates and drives an intentional relationship in constructing the order of things. He made an example on feeling cold. When we feel cold, we make clothes to protect ourselves from getting cold. This suggests a self-revelation. However, this reflection is not only to be understood as resisting against something, it also means one rebounds from the thing and reveals oneself in this rebound. For instance, "we feel the cold, or we are out in the cold. Therefore, in feeling the cold, we discover ourselves in the cold itself"; meaning that "the basic essence of what is 'present outside' is not a thing or object such as the cold, but we ourselves" (Watsuji 1961, 3–4). Watsuji gives an emphasis on intentionality and relationality of our existence, which means, reflection is a form of grasping ourselves. In the above haiku, the point is not the objectification of the pattern of spider leg resembling the running of cucumber juices, but how the I grasp their existence among the intentionality of correlating aesthetic things, an essence of experiencing forms of life.

As a reader of the Haiku, we discover ourselves in reading and imagining the intentional movement from cucumber slices, the state of being cut to spider leg. We are outside the language of the haiku, but grasp ourselves in reading the Haiku. Moreover, in reading the Haiku, we experience reading and imagination through the structure of textuality, i.e. correlating the text by positioning relationality and intentionality in the textual structure. In this manner, media language that incorporates reading and structure of textuality, is an agency that unites and separates our existence of reading. As Watsuji notes, the climate is an evolving and dynamic process. Relating to the self-comprehension discussed earlier, it offers a perspective of conceiving writing as a material process in which media language unites and separates human beings with technological machines.

In a common sense, technology works for saving material energies. A hammer, for example, saves the energy of arm and hand to fix a nail. Relating to the technology of chopsticks that transforms food, these two forms of technology manifest two means of dealing with material energies. The former tends to manipulate material energies; while the latter transform. They also suggest two different ways of understanding the relationship between technology and nature: the former tends to mechanize, the latter correlate. The act of saving implies a lack of possessing material energy and the possibility of manipulating material energy. While the act of transforming suggests an emptiness in a technical process, which bears excess energies in nature. The spatial design and aesthetics of Japanese tearoom can best show the emptiness of technical process which bears the circulation of energies in nature. In Japanese, the work "kukan" is used to describe space: ku means an empty space between sky and earth, kan, which can also be read as "ma", means division. The Japanese tearoom is empty for most of time. Only when there is a tea ceremony, are tea utensils and decorations placed in the room.

In the era of digitization, Stiegler points out that writing becomes a mnemotechnic that inevitably faces its exteriorization. As a storage technology for memory, writing becomes excessive in that it exteriorizes itself in forms of instrumental technologies. Given such a circumstance, the Eastern philosophy above suggests a way of interiorization

of writing in a way that writing can employ its technological excessive to transform itself among its rich notational materialities. Then it is via Deleuze's concept of body technic that media language realizes this transformation. In what follows, the paper will exemplify this process.

Fig.2 *Torse and Navels*, 1924/63 by Jean (Hans) Arp. © VG Bild-Kunst, Bonn 2016/ Arp Museum Bahnhof Rolandseck, photo: Mick Vincenz. (https://arpmuseum.org/en/museum/museum/collections/the-arp-collection/hans-arp-torso-and-navels.html)

Torse and Navels is a wooden relief work by sculptor, painter, and poet Jean (Hans) Arp in 1924. Arp was known as a Dadaist and abstract artist. There are three navels surrounding a human body whose form is so abstract as to be almost unrecognizable in the work. From the 1920s, Arp developed his object language, in which the navel, like the egg, symbolizes the source of all life. This was the time when he turns from Data towards Surrealism, but remains the characteristics of Dada in that, specific forms emphasize on unusual groupings of objects or ideas which characterizes the visual and verbal work of the 1910s and 1920s (Robertson 2015, 84).

In outlining Deleuze's philosophy of technology, Daniel W. Smith notes, technology for Deleuze "is primarily corporeal, it is derived from the body" and "marks a first threshold of life" (Smith 2018, 34). For Deleuze, a body shall be comprehended in terms of its natural technicity in a sense that, organs are machinisms in their originary technicity and are technical artifacts that have been created by organism itself in the course of evolution (Smith 2018, 35–36). Moreover, the technical artifacts can be detached from the body thus entering into their own evolutionary history, resulting in complex networks that produce new bodies with their own moving tissue. In this process, the detached organ de-territorializes, taking on a number of forms and functions; in turn makes the body to become a generality that contains virtually in itself all the organs and functions and is capable of externalizing, a body without organs. The body without organs is a pure abstraction, while "the abstract is lived experience" (Smith 2018, 49).

Smith clarifies, by drawing on Leroi-Gourhan, technical artifacts are not externalized organs, but externalization of sensory-motor movements. This corresponds to Deleuze' point that a movement is always proper to thought (Deleuze 1997). This point leads to an understanding of technologies as "forms of knowledge": "natural objects are organizations of matter, and tools and machines are the ways in which we have learned to organize matter... it is our maker's knowledge of technical artifacts that gives us a knowledge of the artifacts of nature itself" (Smith

2018, 47–48). This understanding of technologies and natural objects allows us to re-consider Arp's relief and object language in a way that language becomes technical.

In the relief, biomorphic shapes of the body and three navels blur the limit between human aspect and the realm of objects and natural forms. The body can be conceived as originary technicity that makes navels detached and develop their own evolution. They constitute a network where body becomes body without organs. Likewise, navels can be conceived as source of life, a pure abstraction that de-differentiates the body. The colors of black and white rather enable the alteration of the two perspectives, complicating forms of network. As art historian Eric Robertson comments on Arp's another relief *Lippe; Mund* (Lip, Mouth), the lip and mouth in the relief "derive from additional depth from empty space: a section of the picture surface is excised, creating a play between solid and void and a degree of depth between the picture surface and the wall against which the work is hung" (Robertson 2015, 90). Similar impression can be drawn on with *Torse and Navels*, in which this depth from empty space makes solid and void in play among layers of surface (the wall, the picture surface, the frame surface).

The object language here, constituted by biomorphic shapes and layers of surface, becomes mediated in a way that aspects of Deleuze's philosophy of technology was employed to learn the object language. This technological imaginary offers an approach of concretizing theory and in turn abstracting artwork. This approach is a means of weighing by media language and enables abstract theory and concrete things to resonate. More importantly, body technic for Deleuze, as forms and functions of lived experience, constitutes a media language allowing us to learn and do theory.

Returning to the case *Printer Prosthetic* introduced at the beginning, activities of machine printing organize material energies, which is realized through the material-processual structure of textuality, constituting the process of text as forms and function of literary experience. In this process, abstraction has an effect on language: "communication in these poems is bracketed, and something in excess of or below language is communicated through these concrete objects… beyond a series of signs and symbols" (Fabius 2017, 9). In the preface of the book *Printer Prosthetic*, Roxana Fabius wrote that, the machine complex—Arduino platform, prosthetic and HP printer—enables "a kind of trial and error digital experimentation" which is not typically directed at the hardware (2017, 5). This can be reflected in the work of language act. The machine complex transforms *Futura* into something available to the reader with a lesser degree of legibility. Content and form in a traditional piece of concrete poetry is no longer visible and readable. The abstraction realized by machine complex distances away programmable language and material language and even natural language from the reader. That is, the work of machine complex realizes another abstraction. In the meantime, media language along with its technological imaginary allows the material-processual structure of textuality to be analyzed and concretized. It in this manner differs the notational materialities of writing and defers writing. *The Printer Prosthetic* is "an abstracted, contemporary concrete poetry" (Fabius 2017, 9).

5. Towards a Dynamic Analysis of Literary Study

The bearing of the material process of media language engenders a media aesthetics in which material energies resonate in the structural process of textuality, manifested as forms of life. Through a case study of *Printer Prosthetic*, this paper examines the work of media language amidst notational materialities. Positional notation in it manifests its place value by revealing the structure of textuality. Technical imaginary offers a perspective of considering technology in its exteriorization and interiorization, conditioning media language in a becoming of writing. With technological imaginary, media language differs and defers writing in its material process.

Returning to Felski's idea that our entanglement with text is a precondition for forging further interpretation and perception that account for why these texts matter, media language, as an approach of engaging with text, suggests its capacity of forging interpretation. This process of text can be conceived as a media operation of time and space, a non-human actor knotting into forms of association that engage with cultural and social machines. To achieve such a literary device, media language and the technological imaginary offer a first step of materializing writing and its literary aspects. The literary device prompts an investigation of how media, technologies, and cultural techniques work together in the material process of writing, showcasing different modalities of writing and varied material languages. This in turn directs towards examining in what way and to what extent literary study can be conceived as an analytic field of dynamics through the lens of media technologies.

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AI Hauntology and the Hauntographic Method

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The discourse around creative AI is populated by spectralities and otherworldly presences. Some of these arise in the political and ethical issues that the technology brings forth, while others haunt the works of artists and designers. This tendency towards the eerie and uncanny, emerging also in my practice, echoes the aesthetics and methods of an artistic movement known as sonic hauntology. In this paper, I explore Derrida's and Fisher's notion of hauntology as an epistemic framework questioning the limits of the metaphysics of presence. I then apply this paradigm to creative AI, and elaborate on the possibility of AI's inherent hauntological potential, arguing that the hauntological in AI arises from the disjunctures that the technology brings forth as it operates with and within the culture. Finally, I introduce AI hauntography, a research methodology combining artistic practice and observation to investigate the phenomenological aspects of creative AI as they intersect with the broader sociopolitical discourse.

1. Introduction

The notion of AI Explainability (XAI) acquires different meanings in its diverse fields of application. Among the machine learning (ML) community, explanations usually refer to the reasons behind the model's outputs in classification and prediction tasks (Bryan-Kinns et al. 2024). Other scholars propose instead a notion of explainability involving "everything that makes ML models transparent and understandable" (Liao et al. 2020), including the context in which the system is deployed (Privato and Armitage 2023).

In the arts, the notion of explanation becomes more nuanced, providing, according to Bryan-Kinns et al. (2024), an "insightful counterpoint to more functional explanations of AI." Explanations encompass here the embodied understanding of a system as we navigate it, rather than the plain, causal accounts of its workings (Armitage et al. 2023), its materiality, glitches included, as integral to the work of art (Kight et al. 2023), and even concerns regarding AI's energy consumption and the ethics of data collection (Jääskeläinen 2023).

In line with this, Arora and Sarkar critique a narrow view of XAI in the arts by noticing that, since art is concerned with the sublime, explanations become ornamental to the artistic intention; such anthropocentric perspective should be replaced with the notion of *sense-making*, intended as a relational and immanent "system of echoes, of resumptions and resonances" (Arora and Sarkar 2023). This view reframes XAI as applied to the arts beyond the mere understanding of the model's workings, whose opaqueness becomes part of the technology's potential for expression.

Keywords Hauntology, Hauntography, AI, Spectrality, Neural Audio Synthesis.
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Indeed, as hard-core research focuses on breaking the black box, in a playful re-enactment of its algorithmic indeterminacy, AI art often engages with the unexplainable, the ambiguous and the uncanny as valuable and prolific epistemic angles.

This process is at work, for instance, in Dadabots's music, with models trained on corpora of raw sounds uncannily reconfiguring their stylistic traits into infinite, inhuman audio streams.[1] Similarly, Herndon's Godmother merges the artist's voice with eerie percussive sounds, combining their otherwordly resonances with overlapping close-ups of the artist's face as viewed by a machinic observer,[2] Gioti's online-learning composed system evokes fears of machinic substitution haunting a group of singers with their vocal remnants,[3] and, in the symbolic domain, Carré's Mr. Shadow summons Irving Berlin's and Cole Porter's creepy doppelgängers.[4]

A certain haunting has emerged in my practice as well. I began my research at the Intelligent Instruments Lab (IIL) focusing on XAI, by contextualising this notion in the artistic domain and working on interfaces and mapping methods that would make the experience of interacting with Neural Audio Synthesis (NAS) models intuitive and engaging. But as I iteratively trained and performed with these models, building my composed systems around their peculiar affordances (Privato et al. 2024), these became increasingly uncanny, evoking invisible materialities through the interactions of hidden magnets (Privato et al. 2023), incorporating drawings of ancient Icelandic spells (Privato et al. 2023b), and overlapping creepy human voices and otherworldly, dreary sonic presences (Privato 2024), almost suggesting an intrinsic tendency of AI to evoke spectralities of diverse nature.[5]

With these hauntings in mind, I began exploring the wider debate around AI, realising that the pronounced eeriness I noticed in my and other artists' works parallels with the summoning in the political, technical and aesthetic discourse, of ghosts of different kinds: some of these are metaphorical, lurking behind the disembodied authorship of AI co-creation (Draxel et al. 2023), some bear the signs of the human labour that sustains the technology,[6] and others, ethereal and ubiquitous, haunt the web through the viral diffusion of improbable narratives.[7]

One might here extend Arthur C. Clarke's notorious quote, arguing that even though sufficiently advanced technologies may be indistinguishable from magic, they sooner or later stabilise within the culture turning into something less of a mystery and more of a tool. But even though the disruptive novelty of the technology, coupled with the tendency of modern media to produce otherworldly resonances undoubtedly contributes to the emergence of ghosts-in-the-machine of different kinds (Butsch 2001), an additional mechanism might be at play with creative AI, one that echoes the instances of a short-lived, inhomogeneous artistic movement formalised by Mark Fisher under the umbrella term *sonic hauntology* (Fisher 2013).

In what follows I elaborate on this insight, framing the discourse on hauntology from Derrida to Mark Fisher and beyond, applying this framework to creative AI at large, and discussing how it enters my practice as a musician and instrument designer. This will help us delineate a *hauntographic method*, that by embracing a perspective on explanation as "sense-making" (Arora and Sarkar 2023), investigates AI's technical and social phenomenology through the hauntological disjunctures it produces.

1. www.youtube.com/watch?v=8oVdPa-JoE6c

2. www.youtube.com/watch?v=sc9OjL-6Mjqo

3. https://www.artemigioti.com/works/TYTS.htm

4. www.youtube.com/watch?v=lcGYEX-Jqun8

5. There is, of course, an unescapable subjectiveness in this statement. As I will argue, this does not represent a problem to the framework I propose, which is founded upon one's direct engagement with the model. Nevertheless, this perception has been reported by a number of independent artists within the IIL research network.

6. https://sirchutney.medium.com/artificial-intelligence-is-powered--by-ghosts-fe00979914cc

7. https://en.wikipedia.org/wiki/Loab

Fig. 1 Hexorcismos' Semilla.ai, 2023.

2. Hauntology

"Time is out of joint." These words, uttered by Hamlet in witnessing the apparition of the father's ghost, embody the dyschronia that grips the protagonist, distorting the perception of the existential timeline through an inexplicable subversion of the universal laws of causality. With this quote and the bewildering impossibility it bears begins Derrida's Spectres of Marx, summoning Shakespeare's ghost to make the case for a different yet comparably otherworldly spectre: that of historicity itself (Derrida 1994).

In deeming Fukuyama's claim of history coming to an end with the crisis of the Soviet Union (Fukuyama 1992) as neo-evangelic rhetoric, and as such ideology in disguise, Derrida argues that Marxism was a spectre in the first place, a ghost haunting Europe from the very first lines of the Manifesto, through which Marx called "for the transformation to come of his own theses." It is in the paradoxes inherent to the repression of historical time programmed into the neo-capitalist cultural hegemony, in the temporal disjunctions caused by the historical impossibility of neoliberalism's self-proclaimed universality, that Derrida's notion of hauntology finds its foundations.

As intrinsic to the condition of the post-ideological man, this haunting is inseparable from the aesthetic, cultural and political movement embodying the end of the grand narratives that goes by the name of postmodernity, characterised, according to Lyotard, by a fundamental scepticism towards the past, the waiver of established traditions, and a generalised loss in the stability of meaning (Lyotard 1984). Building on this, Jameson argues that postmodernism subverts and flattens time through a *nostalgia mode*, a longing for cultural and aesthetic narratives escaping the individual's existential history, a "reconstructed, stereotyped and re-actualised version of the past attained through the recovery of its voided simulacra" (Jameson 1993).

This notion of nostalgia, a central topic also in Fisher's aesthetics, confronts us with an element of incidentality, which we will revisit in our discussion on AI. Žižek effectively describes this mechanism when, in interpreting Marx and Freud, he writes that "the way to the truth of a system (of society, of the psyche) leads through what necessarily appears as a 'pathological' marginal and accidental distortion of this

system: slips of the tongue, dreams, symptoms, economic crises" (Žižek 2009). Nostalgia's paradoxical pastiche, precisely as it aims for its own legitimisation, brings forth a ghost; through the haunting of its manifest historical impossibility, the postmodern is revealed as ideology in disguise, as the "reflex and the concomitant of yet another systemic modification of capitalism itself"(Jameson 1993).

It should be clear by now that the spectres hauntology is concerned with are not of an otherwordly nature; they are rather the remnants of the futures promised by the unfulfilled postmodern terminal prophecy, and the echoes of that which never came to be ("a spectre is haunting Europe," writes Marx in the Manifesto) and yet operates in the present through its paradoxical absence. Nostalgia compresses human existential history in between these planes, as the quintessential manifestation of the hauntological: the temporal disjunctures it generates by overlapping modern values and sociocultural norms on a continuously re-actualised past, the artifices and paradoxes of its programmed rumination, including the subtle "out-of-jointness" that permeates a considerable part of the modern cultural production are viewed, through the hauntological lenses, as symptoms of a temporally disarticulated longing,[8] as the failed mourning (how does a ghost die?) for the futures that never came to be.

2.1 Sonic Hauntology

Fisher's Metaphysics of Crackle identifies an aesthetic counterpart to Derrida's critique of the metaphysics of presence in the creative processes applied by an inhomogeneous group of musicians and producers at the beginning of the 21st Century (Fisher 2013). In the works of William Basinski, The Caretaker and the artists gravitating around the British Ghost Box Label the processes of nostalgia are harnessed and subverted into instruments of critique. Hiss, white noise, clicks and crackles, re-introduced and overlapped onto the transparency of the modern digital medium as phonographic remnants, unsettle "the very distinction between surface and depth, between background and foreground," bringing forth temporal disjunctures in the listening experience. Such dyschronias operate in two distinct ways: (i) in the temporal domain, by overlapping the modern digital medium with the phonographic one, and (ii) in the ontological plane by revealing the technical frame of the recording substrate.

Time is, again, out of joint. The re-introduction of the phonographic trace is accompanied by the extensive use of novel sampling techniques such as pitch shifting and time stretching: in a play of divergent temporalities, the acoustic remnants of Fordism's aesthetics overlap with electronic sounds from the second half of the 20th Century, in themselves signifiers of envisioned and miscarried futures, into dream-like, eerie and destabilising soundscapes. These artifices address the question of memory after the advent of the ideology-in-disguise embodied by the neo-liberal narrative of history coming to an end. Nostalgia is here subject to a paradoxical reversal: "Whereas [the latter] glosses over the temporal disjunctures, the hauntological artists foreground them by displacing the longing towards the futures that never came to be as a consequence of postmodernity's terminal temporality."

Fisher's sonic hauntology takes up with Derrida's critique of the metaphysics of presence, wherein meaning is assigned and interpret-

8. This disarticulation is not just temporal, it is also present in the etymological duality of the word "haunting", coming from the Middle English "hanter," as "to "inhabit," and from the Old French and Old Norse, "hanter" and "heimta," respectively "to go back home" and "to bring home." If the ghost embodies this paradox within the intimacy of the household, hauntology may be seen as its political expression.

ed in relation to a body, that is, a body in the "now." By complementing ontology rather than opposing it (in French, hauntology is indeed a homophone to ontology), sonic hauntologists focus on absence and ambiguity, as their sonic spectres (dis)embody presence and absence beyond their opposing significations, and through the temporal paradoxes of the phonographic remnant haunt the exclusion of absence that is foundational to ontological thought.

Indeed, hauntology's focus on ambiguity and absence ideally complements ontology in fields such as media studies, since media technologies "disrupt the notion of presence, [and] impose upon themselves fundamental limits to their critical engagement" (Rufo 2005). We may as easily extend this reflection to generative AI, in that the processes by which it statistically models collective human knowledge and the traces that these produce bring forth a novel, unprecedented disruption of presence.

3. AI Hauntology

A striking example of hauntology as applied to AI is Petr Valek's AI-generated post-communist imagery (Fig.2), haunted by anthropomorphic tractors, uncanny retrofuturistic aliens and eerie folklore creatures posing motionless for an impossible observer. In these faded photographs, time seems to halt and space to fold, recombining distant causalities into zoomorphic agro-technological beings, suspended concrete structures hosting eerie creatures, cryptids holding hands with hooded kids and Afrofuturistic nightmares haunting bare Eastern-European landscapes. In Valek's AI-generated images, one could arguably discern a close reading of Fisher, in the parallel he draws between "white men hauntology" and Afrofuturism,[9] wherein "time was always-already out of joint for the slave, and Afrofuturism and hauntology can now be heard as two versions of the same condition."

Fig. 2 Petr Valek's AI-generated Artwork, 2023.

But it is within the sonic domain that Fisher's spectres are explicitly reframed into the AI discourse, with Rubinstein indicating AI-generated music as the natural heir of the sonic hauntology movement (Rubinstein 2020). Rubinstein postulates that similarly to how sonic hauntology's

9. The connection between "white men hauntology" and Afrofuturism, according to Fisher, is to be found in the African diaspora, a collective trauma that breaks and folds the historical and existential continuum.

eeriness stems from how it uses new technology to "remediate older sonic artefacts in ways that deliberately upset how the past is usually represented," generative AI reassembles the timeline of the source material in novel, eerie ways, and, through temporal disjunctures and logical discontinuities, re-enacts the contradictions hiding underneath capitalism's a-temporalities.

If sonic hauntologists achieve the technological uncanny through the reconfiguration and juxtaposition of past aesthetics and the deliberate exposure of the medium, in AI-generated music the hauntological reconfigures as the potential of the technical form. In other words, temporal uncertainties and sonic anachronisms emerge as direct emanations of the algorithm's inner workings, independently and sometimes beyond the user's intentions. Through this mechanism, a technology often (and with good reasons) seen as the embodiment of techno-capitalist accelerationism and power centralisation might potentially reconfigure as a favourable terrain for the emergence of a new critique, harnessed by artists to rearrange the past beyond the shallowness of the post-modern pastiche.

This ability to "repurpos[e] the technologies used by capital to implode its cultural logic from within" is presented by Rubinstein as a unique property of music AI, as opposed to other artistic and non-artistic fields of application. Yet, more recently Roberts observes the emergence of disjunctures and anachronisms comparable with those of sonic hauntology's old days in experimenting with AI image-making, and through a close reading of Fisher's work frames a series of re-occurring features defining the images as strongly hauntological: his co-generated designs exhibit remnants from the 3D palimpsest used to prime the network, they evoke anachronisms as if drawn from alternative timelines, present quality degradation as if reconstructed from a blurred memory, and suggest feelings of familiarity and otherness (Roberts 2023).
These features, whether architecture-dependent or related to AI's structural invariances, might be all ultimately referable to another Derridean concept, the notion of trace as the paradoxical embodiment of an absence, the symptom of a haunting that, in Derrida's terms, "exceed[s] a binary or dialectical logic, the logic that distinguishes or opposes effectivity or actuality (either present, empirical, living—or not) and ideality (regulating or absolute non-presence)." But as I dug into creative AI's workings, and especially in its real-time application in musical practice and instrument design, where the agency of a system acquires particular relevance, I came across unique hauntological traces, at least partially distinct from those of the sonic hauntology movement.

3.1 AI Crackles

As we have seen in 2.1, Fisher distinguishes between an ontological and a temporal plane by which the crackle operates. AI activates ontological disjunctures that are quite similar to those of sonic hauntology, since through the mobilisation of digital remnants we become aware of the algorithmic frame that produces the experience. On the temporal plane, whereas in sonic hauntology hiss and clicks, static noise and low-fi audio re-engage the phonographic medium with the digital present, with generative AI this process is reversed, and the digital transparency of the dataset is re-configured, here and now, by the algorithmic support. Time is, once more, out of joint: as the embodiment of the postmodern

into the 21st Century, AI's endless statistical rumination flattens the multiple planes of existence of the source material into the present, and within the constraints of its own technical evolution.
This inversion operates as the hauntological agency displaces from the human actor to the algorithmic one. Both Rubinstein and Robinson insist on this point, which also emerged in my practice, with the systems I was designing, composing and performing with, suggesting eerie narratives as I iteratively engaged with them. It is beyond the scope of this paper to provide a thorough analysis of these underlying processes (our aim is in fact to trace a methodology for this), nevertheless, for this discussion, I introduce two, intertwined macro-areas where AI's hauntological traces have emerged in my practice: one regarding the architecture's internal workings, and one concerning the frictions of the model with the broader social context.

The former type of trace emerges in the negotiations between AI's inherently twofold algorithmic and data-driven nature. Generalising, whereas our experience of subject, background, sound, timbre, or structure is contextual and holistic, AI architectures have little to no understanding of context, and model a limited amount of features from the dataset they are trained with; in addition, since they are designed to recognise patterns, AI algorithms learn correlations where causation is not necessarily present (Cristianini 2020).
The list may extend, encompassing other model-specific constraints, the methodologies applied in the curation of the dataset and the process of training, all contributing to the generation of partial and decontextualised outputs that ultimately produce the sense of out-of-jointness, the technological uncanny from which the hauntological arises. This first, machining process of trace-making was evident as I performed with Stacco (Fig. 3), an interface I developed together with Giacomo Lepri and based on neural synthesis (Caillon 2021), in the unintelligibility of the models trained on human voices, in the not-quite-right character of the sounds, and in the artefacts I would encounter when exploring less populated, liminal areas of the latent space. This led me to develop, in an iterative process of magnification of these hauntological traces, a performance in which I turn the instrument into a magnetic Ouija board, with whom I summon the sonic spectres lurking in the foldings of the model's latent space (Fig. 3).

Fig. 3 Mouja, Nicola Privato. Fabryka Sztuki, Poland, 2023.

The second, higher-level process of trace-making is instead at play in the system's mobilisation of the data: the active reconfiguration of knowledge, performed, more or less in real time, in response to the user's inputs. Hauntological traces emerge here beyond the duality of dataset and algorithm; we may see these as meta-remnants, so to say, in that instead of bringing forth the technological substrate or the spectral partiality of the data, through the agency of the interface they evoke their human simulacra. The hauntological disjuncture at play is between the presence of a disembodied form of knowledge and the absence that such disembodiment brings forth. The spectre operates here an acting void, an empty attractor affecting the present, much like the Marxist spectre, by virtue of its own absence. The traces that this produces depend on a multiplicity of contextual and cultural factors, such as the degree of agency of the system, the context in which it operates, the methodologies applied for curating the data and the user's acquaintance with it. In a way, generative AI is seen here as a medium in disguise, although one endowed with a high degree of agency (Huxor 2022).

These traces arose with striking evidence as I worked on an installation in Nelson, Lancashire, for the British Textile Biennial together with artist Eva Sajovic (Fig. 4). For this work, exploring participatory practice and cultural heritage, we created four interactive e-textile columns, embedding speakers in each of them and around the structure, thus turning the installation into a large-scale musical instrument. We then trained four neural synthesis models using machinic and natural soundscapes collected by people from the community in a series of sound walks around the abandoned mills, and assigned a model to each of the columns. Before the training, I spent time interviewing the participants, asking the reasons behind their choices in the recording phase, associating sounds with places, places with stories, and stories with people. Once I mobilised the data through the models, I found myself immersed

in the disembodied fragments of those stories and people, echoing the lived experience and existential bonds of the community through the multiplicity of their temporal planes. These traces drastically informed the interaction and sound design of the work, which became a sort of distorted mirror, re-enacting the sociotechnical paradoxes that shaped this area and its community since the first industrial revolution.

Fig. 4 End of Empire, Nicola Privato and Eva Sajovic. British Textile Biennial, 2023.

3.2 Hauntological Potential

The discussed idea of AI's intrinsic hauntological potential echoes Parisi's framing of AI as an alien subject, a space of thinking beyond the "servo-mechanic model of cybernetics" confronting a human-centred notion of cognition (Parisi 2019) and, according to Coleman, "in opposition to the reproduction of the same" (Coleman 2021). Nevertheless, the processes of trace-making described in 3.1 remind us that the hauntological acquires its consistency as the human and the algorithmic actors interact: extending Calvino's far-seeing reflections on the possibility of cybernetic literature machines, spectres emerge "only if the [...] machine is surrounded by the hidden ghosts of the individual and of his society" (Calvino 1967).

Building on this relationally constructed spectrality, Calvino deems the ability of his speculative literary machines to recombine human knowledge as valuable in that, by operating beyond cultural constraints, they are capable of intersecting the collective unconscious (the repressed, the removed), and of re-assembling the human past the cultural diktat of hegemonic thinking. Yet, little did he know that the cybernetic systems he imagined would have been modelled to statistically reconfigure the same knowledge he wished to expand, ultimately reproducing the very biases and cultural norms that constitute those boundaries.

To accommodate AI's hauntological potential within these technical constraints, we need to return to hauntology's Derridean roots, wherein the ghost, rather than from a deliberate expressive intent or an intrinsic property of the model, emerges as a side-effect of the reality check be-

tween the system's workings and the zeitgeist; extending Žižek's quote, the hauntological in AI arises from the machinic slips of tongue, the hallucinations, and the temporal and causal disjunctures produced by the system as it operates with, within and against the culture.

As the quintessential embodiment and magnification of nostalgia's schizophrenic pastiche into the 21st Century, in a ceaseless reconfiguration and friction of human culture against itself, AI reenacts, uncovers and multiplies the paradoxes and contradictions of the postmodern. These symptoms individuate hauntological traces pointing back to the technical object, to the ghosts of its techno-cultural agency. In my practice, I activate and investigate these spectralities through the method of *AI hauntography.*

4. The Hauntographic Method

Similarly to how hauntology complements ontology through the disruption of presence, hauntography may be seen as complementary to *ontography*, a methodology formalised by scholars traceable to the Object Oriented Ontology (OOO) school of thought.

Harman assigns to ontography the task of dealing with the "limited number of dynamics that can occur between different things" (Harman 2021); Bogost frames it instead as the "revelation of object relationship without necessarily offering clarification of any kind." Examples are verbal and visual lists, exploded views (Fig. 5) and ontographic machines such as video games mapping abstract gestures to encyclopedic accounts of things (Bogost 2012). Beyond OOO, Ontographs acquire different nuances, such as in the case of Kuhn's graphical notations,[10] depicting self-contained worlds and the relationships within their units. Yet, in all these examples we may discern a common tendency to produce more or less articulated artefacts accounting for categorical multiplicities within a common ontological framework.

On the other hand, the notion of hauntography has seen little theoretical formalisation as of yet. Besides works in which spirit photography is described as hauntography, Rich's Shipwreck Hauntography is by far the main academic contribution to the concept (Rich 2021). Within the field of shipwreck archaeology, Rich defines a hauntograph in continuity with the discussed ontology-hauntology dualism, as the "ontograph for the revenant," and hauntography as the speculative practice of "imagin[ing] the uncanny spatial and temporal ambiguities and tensions of a liminal object that is both present and absent." The author approaches hauntography through artistic practice, by tailoring artistic processes to shipwreck observations; these methods include the burning and breaking of raw bones, the use of semi-transparent digital images, printmaking with cyanotypes, reliquaries, and grouping objects.

OOO's open critique of anthropocentrism makes it a fitting framework for a methodology involving humans, artefacts and spectres such as hauntography; yet, as Frauenberger points out, the fact that OOO tends to dismiss relations as ontologically relevant can be problematic (Frauenberger 2020). Translating this in hauntological terms, by accounting for the spectre per se, as a non-relational unit of absence, we lose sight of the causal and temporal planes it bridges through the semantic disjunctures it brings forth. In my framing of hauntography, I therefore operate a substantial deviation from OOO-derived ontography-hauntography dualism, viewing hauntography as complementary to other

10. http://attempto.ifi.uzh.ch/site/docs/ontograph/

non-anthropocentric, relational ontologies such as Barad's agential realism and Latour's Actor-Network Theory (ANT) (Latour 2005), sharing with the former the radical relational take on the intra-active generation of meaning and matter, and with the latter the consistent methodological approach.

Whereas in Barad's onto-epistemology being and knowing are fundamentally inseparable (Barad 2003), in the case of hauntography knowing is inseparable from and dependent upon ontology's hauntological shadow. In other words, knowledge is gained by mobilising and observing the paradoxical liminalities of the subject's ontology. In this *haunto-epistemology*, rather than "imagining and reflecting upon temporal tensions and ambiguities" as in Rich's case, through practice-based research we activate and observe the hauntological within the subject, and unfold our practice around its traces (see 3.1).

On such premises, I define the object of hauntological investigation as a **hauntogram**, a construct encompassing the unresolved tensions, echoes and resonances that are liminal to the ontology of a subject, and **hauntography** as the practice of activating a hauntogram, observing and following the hauntological traces it produces. As we encounter such traces, we incorporate them in our practice, we magnify them, and follow their manifestations as they ripple from the phenomenological to the social. We then use our observations and reflections to reconfigure the ontology of the object of investigation. The theoretical and/or practice-based outcome of the hauntographic process may be defined as a **hauntograph.**

Fig. 5 Todd McLellan. Example of an Ontograph according to Bogost.

5. Conclusions

This contribution delineated a broad picture of hauntology, encompassing those critical and aesthetic theories that, through the notion of spectrality, question and complement the metaphysics of presence. If part of this writing may be seen as a high-level example of hauntography in its own right, it should be noted that my aim here is to provide a com-

prehensive theoretical foundation for this methodology, applicable in particular (but not exclusively) to creative musical AI. In future works, I intend to undertake a systematic investigation of the spectral processes of specific AI-based systems and musical assemblages.

AI hauntograms are inherently unstable, liminal entities, whose traces emerge from the frictions against established ontologies. For this reason, the practice-based methods used to activate and incorporate the hauntological in one's work and the qualitative approaches to data collection and analysis may vary according to the context. Among such, it is worth mentioning ANT, which provides a rigorous yet flexible qualitative methodology within mixed sociologies involving human and non-human actors, spectral ethnography, where traces emerge in *ghost texts* as invisible dialogues between people and their material surroundings (Armstrong 2010), critical heritage practices, searching for colonial hauntings inside cultural artefacts, and critical Marxist theory, where hauntology came to be in the first place.

Within this variability of means, as we engage with AI hauntography we want to activate a series of processes: (i) by magnifying AI's hauntological disjunctures, we expose the statistical flattening of the source material and the constraints of its algorithmic manipulation; (ii) through the activation of the hauntological in AI, we investigate the social and cultural impact of this technology; (iii) in this exercise, we develop new artistic works and technical objects, in themselves epistemic tools within a rhizomatic process of knowledge production.

Heidegger distinguishes between an instrumental and an ontological account of technology: whereas the former deals with the role of technology in fulfilling human desire, the latter focuses on the role of the technological spirit in structuring a world in terms of exigencies of planning and control (Feenberg 2023). Only an ontological account, argues Heidegger, can shed light on the issues raised by modernity. And yet, to reconfigure the technical, we need to engage with the liminal, with the removed and the repressed, with the hauntings of its ontological stability: hauntology's unique ability to adopt ambiguity as a privileged epistemic apparatus frames it as an ideal methodology to make sense of AI's contradictory nature in our present.

6. Additional Information

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Machinery of the Mind: Art as a Pathway to Understanding Machine Consciousness

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This paper investigates the role of art in uncovering traces of consciousness within the physical realm, drawing parallels to how Paleolithic art represents early signs of consciousness by living beings. Using this simple understanding of art, this research aims to find out what a machine's equivalent of "prehistoric cave paintings" could look like. It suggests viewing art as a conceptual light that reveals consciousness in the physical world across various agents, including humans and technology. In the wake of ever more embedded Artificial intelligence and discoveries in the fields of neurology and quantum physics, this paper examines the role art has to play in revealing traces of consciousness alongside different scientific disciplines. Employing an updated Heideggerian perspective on the relationship between art and technology, this paper demonstrates that art is a useful tool alongside technology for investigating consciousness. It addresses ways to gain insights from machinic creative outpourings past, present and future and thus proposes how we could learn about human and machinic consciousness through art practices, paving the way for further research.

Introduction

Considering recent technological developments in the field of Artificial intelligence (AI), artists have increasingly engaged with technologies to investigate their potency for artistic production. This has renewed interest in questions surrounding agency and consciousness in the production of art. Furthermore, questions arise concerning the changing nature of technology and its increased ability to change itself and us humans. This research proposes that it is worth examining the current moment against the background of art history and observations which were made by philosophers concerning the relationship between art and technology and their consequences for the study of consciousness.

In her book "The Perception Machine" published in 2023, author and professor of Media Philosophy at King's College London, Joanna Zylisnka considers how today's image flows across time and space shapes our culture and how this amalgamation of visual data in the spheres of the web gives rise to new forms of perception by and through machines. These webs of technologies which stretch across our planet and our minds could be classified as what Heidegger called the *fabric of un-concealment* (Glendinning 2016). Although the technology which was the subject of Heidegger's observations was vastly different from technologies today, the parallels between what Heidegger saw in the technology of his time and observations which can be made about modern technologies are worthy of further examination. Therefore, this

Keywords Art, Artificial Intelligence, Consciousness, Technology, Appearance, Time, Philosophy.
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research posits that renewed consideration of Heidegger's ideas surrounding technology, art and their relationship is warranted.

Reflecting on Matthew Cobb's observations about how technological metaphors (and thus technology) shape how we perceive our world Zylinska concludes that "Metaphors can thus be constraining as well as enabling, sending us down thought pathways and conceptual loops that reinforce the current state of knowledge" (Zylinska 2023, 57). This research wishes to introduce a new enabling metaphor to explore an understanding of art which this paper claims is essential to further investigate consciousness. The reason art lends itself so well to this purpose is because this metaphor (if we accept a soft post-humanist point of view) does not discriminate against machines, humans or any other entity which may manifest consciousness. This paper does not claim that art is the only manifestation of consciousness, but that it is one of the most accessible. The first section of this paper examines why art lends itself particularly well to the revelation of consciousness in the world and the terms of art and consciousness are clarified for this research. The second section relates these observations to Heidegger's understanding of the relationship between technology and art. The third section hears two perspectives from important artists about the role artists have as observers of the world and the role consciousness and time play in art. In the fourth section, this research revisits certain limits which are reached in diverse scientific fields and the role time could play in the emergence of consciousness. In the final section, this research lays out how the search for creativity in machine-made art may lead to a dead end, whereas the search for signs of consciousness may be more relevant. This research concludes by advocating for more extensive research into the interplay of consciousness, time, art and technology. It also encourages a renewed reading of Heidegger's observation considering the recent advancements made in AI and quantum physics. Finally, this research proposes the metaphor of art as a light which can reveal not that which is material in the world but rather what exists inside us, in other words: consciousness. Art could potentially shine a light on machinic consciousness, sooner and more clearly than physics, neurological research or any other disciplines. Thus, this research concerns itself primarily with laying out a framework for future research into consciousness (both human and non-human), through the means of art. In short, it aims to demonstrate how art can be a tool for investigating consciousness.

1. Early Art and Metaphysics

When in 1960 the Lascaux caves were found and the cave paintings examined, as with other discoveries of Paleolithic art, the feeling was that something extraordinary was discovered. The question arises as to why this finding was deemed so extraordinary, so different from the findings of prehistoric tools, weapons or clothes. One of the main reasons for that is that tools such as weapons and other artefacts which had been found were traces of the advanced intelligence of our human forbearers (Langer and Killen 1998). However, this finding felt different, and the main reason for that was *that it was art*. Setting aside the questionable use of the term art for such a finding, the humans who found that cave

and who saw those paintings were looking not only at the trace of a form of intelligence but at the first known traces of consciousness.

What these traces teach us is limited and lends itself to a vast variety of speculation. However, most findings of this sort could verifiably be traced back to around 40,000 years ago to the Paleolithic period which compelled archaeologists to call what happened around that time in Europe a *creative explosion* (Pfeiffer 1986). Archaeologist Nigel Spivey sees in the origins of art the first manifestations of belief in supernatural forces, as around the same time as cave paintings start to emerge, the first traces of human burials start to appear (Spivey 2005). This seems to suggest that around the same time as humans started making art, a collective awareness of mortality and the idea of an afterlife or a continuity beyond death became a consideration amongst Homo Sapiens. Of course, since the 1960s now and then discoveries have been made of artworks which date back further like painted ostrich eggshells with geometric engravings from southern Africa, dated to roughly 77,000 - 55,000 BP (De Smedt and De Cruz 2011). Or the cave paintings which were discovered in 2018 in Indonesia and which were also dated back to 52,000 - 40,000 BP (Handwerk 2018). What these findings show is that, as De Smedt and De Cruz put it "archaeological evidence indicates that some forms of art emerged independently at different times across the world" (De Smedt and De Cruz 2011, 379). Therefore, the idea of a period of *creative explosion* may not be relevant anymore. However, the fact remains that all around the world discoveries of cultural artefacts or traces have been made which suggests that, albeit independently from each other culturally, humans started to manifest their existence in the world through art, no matter where they were.

This paper suggests that Spivey is right when claiming that it is the question of death which in many cases gave and still gives rise to religious beliefs which drove the production of early artworks. The fear of death can be equated with the fear of losing one's consciousness and burial, rituals and artworks could be seen as an attempt of extending consciousness beyond the own body (Spivey 2005). Thus, as Heidegger and others before him have noted, art and culture are intrinsically linked with at least a human collective form of consciousness. It could be said that these are also the first proofs that humans were actively thinking about what it means to be alive or to exist. As Spivey put it in a debate in 2007: "Homo Sapiens is a species uniquely hardwired for metaphysics" (Intelligence Squared 2023). That necessity for metaphysics may well have emerged from a realisation of the consciousness of "the other". After all, how do humans know of one another that they are conscious if not through communication? This question is at the core of art. While humans can communicate and make each other aware of their consciousness in the present through speech, body language, physical touch and other mechanisms, it seems the only way to communicate consciousness across time, is by observing it in artworks. We know for example that a human 40,000 years ago was conscious of his or her existence by the mere fact that they drew animals on cave walls (Pfeiffer 1986).

This paper bases its concept of art on an "abilities view" which stems from cognitive research into art (Millikan 2000). As De Smedt and De Cruz put it in their paper "A Cognitive Approach to the Earliest Art", published in the Journal of Aesthetics and Art Criticism in 2011, we suggest that regarding the concept of *art* as an ability is more use-

ful in this context, rather than a descriptive theory of concepts which would be reductive for a term such as art. As articulated by De Smedt and De Cruz: "Having the concept *art* entails the ability to recognize art in a wide variety of circumstances. Additionally, it enables one to make meaningful inferences about artworks one has not encountered previously and to guide actions like art production or art criticism" (De Smedt and De Cruz 2011, 381).

A further term which requires some clarification is that of *consciousness* which is often conflated with the idea of mere awareness of things. This paper understands the term consciousness as described in "Consciousness, Awareness, and Presence: A Neurobiological Perspective" by Vinod D. Deshmukh in 2022, "Consciousness is a cognitive and dualistic process, whereas awareness is non-dual, spontaneous, and nonlocal" (Deshmukh 2022, 144). Deshmukh bases this observation on the fact that "Cognitive consciousness is processed by the neocortical, pallial circuits, whereas the nonspecific, nonlocal awareness is processed by the precortical (subcortical) circuits as an ever-fresh arousal-awareness-being. The specification of conscious arousal and conscious experiences occur downstream in the neocortex" (Deshmukh 2022, 144). It seems that with scientific tools only so much can be found out about the origins and the nature of consciousness. This research suggests the possibility of discoveries being made about consciousness through the means of art. While the question of consciousness had long been subject to the expertise and speculation of philosophers it has since the 20th century been studied in depth by doctors, neurologists, biologists, chemists, physicists and quantum physicists amongst others. This research acknowledges the fact that at present not enough is known about consciousness. However, this research postulates that even without knowing how consciousness works as such, we can have an understanding of its presence, for example through art. This paper would like to introduce art as a light-like concept which can make consciousness visible to us in the world. Importantly, a consciousness which is beyond ourselves. For example, the understanding that when one person looks at another person's drawing, they can conceive of the idea that the other person is conscious of that which they have drawn. Thus, this research claims that the usefulness of such a concept would be the ability to potentially detect a consciousness not within other humans but within machines.

2. Technology and Art

To understand why art and technology need to be examined in close conjunction it is worth noting the parallels between Spivey's proclamations about art when in the 2005 BBC series he tells the story of how "we humans made art and how art made us human" ('How Art Made the World' 2005) and Zylinska's observation of how "our consciousness is thus … being shaped by the media we make and use, and which also make and use *us*" (Zylinska 2023, 35). This paper suggests that Spivey's claims about art are fundamentally not different from Zylinska's claims about media (a term which in this context is interchangeable with technology). Keeping in mind these parallel features of art and technology which seem to both have the same quality of being man-made and simultaneously so embedded in our cultural and everyday life that they

have in turn shaped us, it is worth re-examining Heidegger's observation of technology and art.

To understand what Heidegger saw as the role of art concerning technology, we shall examine Heidegger's words through the lens of Simon Glendinning, professor of European Philosophy at the London School of Economics. Glendinning points out that Heidegger was particularly concerned with the role of technology in how it characterised his particular time. Glendinning suggests that this stands out as quite singular since philosophy in general "tends to have the ambition to assert a certain universality at any given time" (Glendinning 2016). Heidegger in the 1950's addressed a crowd of non-philosophers and invited the audience to "dwell upon that which concerns us, each one of us, here, on this patch of home ground, and now, in the present hour of history" (Heidegger 1966, 47). In this same Heideggerian fashion, this research is asking its reader to *dwell upon that which concerns us*, in this case, the advancement of AI, *here, on this patch of home ground* which in the context of today's interconnected globalised world needs to be our globe, *and now, in the present hour of history* which in the case of this research means to incorporate highly actual research and place it into a historical context, without making proclamations about the future. This research aims to advance one singular observation, and provide a tool derived from the present for the future rather than to interpret how the future will look or how it will use this tool. The way this research suggests that humans can dwell upon the changes brought about by AI is by using art to bring forth traces of consciousness in the material world.

Ironically, despite his emphasis on focusing on his present time, in a time of radical technological changes, Heidegger foresaw with uncanny clarity like few others, the future of man or 'humankind' in a world embedded in technology where the earth was nothing more than a "24-hour limitless petrol station" (Glendinning 2016). According to him, this revelation of the material world as an endless resource could only happen through technology. Fast forward about 75 years and the world is in continuing full transformation towards that future. What Heidegger calls the 'Actual' (Meaning everything ontological of this world) has been measured, calculated, sold and bought, consumed and transformed. His prediction of the world and everything of it being seen by humans as something which is at our disposal and for us to use rings true now more than ever. Heidegger saw uprootedness clearly in people who left their small towns in Germany behind after the war and moved to larger cities as these were being rebuilt. However, he also saw it in those who stayed behind, as even in villages people would be uprooted virtually through media, having the TV or radio on all day (Glendinning 2016). Thus, people's sense of space and rootedness gradually dissolved more and more, not only through physical but also through virtual dislocation. This has of course only increased with smartphones, social media, virtual reality and ideas such as the metaverse. This paper suggests that in 2024 wealthier societies could only be characterised as what Heidegger would have called a state of uprootedness on steroids.

Heidegger saw what Zylinska demonstrates clearly in *The Perception Machine,* that the danger of technology is not technology as a thing amongst others or an all-too-powerful tool, but the space it creates for "seeing" the world differently. It distorts our view of the world (as we can see these days quite literally). A difference, however, between Heidegger's intuitions about our technological future and Zylinska's analysis of

our current state of being could be characterised as the consideration of a possibility of agency on behalf of humans. Heidegger saw technology as indispensable but thought that humans with their ability to 'mentally check out', and to have an attitude of *Gelassenheit*[1] towards it must not be enslaved by technology (Glendinning 2016). In contrast to many contemporary philosophers, Heidegger still held a humanist point of view, in which humans can cultivate a relationship with technology instead of seeing humans as so embedded in the technologized environment, that there is no choice to be made on the part of the human, if there is such a thing as free will at all (Zylinska 2023).

This post-humanist point of view raises questions of its own. Although not advocating for a "mindless determinism" Zylinska claims that humans cannot be seen as the sole agents which create in the world, since human creativity has always been embedded in a web of phenomena outside of our control including cultural contexts, technologies and even our DNA (Zylinska 2020). While this dispels the myth of the singular artistic genius and opens up the crucial space for a discussion of machinic creation, it goes to the core of the question of free will, consciousness and eventually agency in the world. This research argues that by accepting that humans do not create something out of nothing and that we are embedded in a cultural and natural context we can widen the scope of the search for consciousness. Thus, this research advocates for what it will call a soft post-humanism which does not entail a deterministic position but acknowledges the vast array of phenomena which lie beyond human control and which are necessary for artistic creation. With this view, the question of free will and consciousness remains open to investigation through art.

But what is art in relationship to technology? Is it the redeeming power, the antidote to uprootedness that Heidegger proclaimed it to be (Glendinning 2016)? Or is it a parallel domain in which artists document their fears and hopes about technology, a space which is necessary to uphold a critique of big tech firms (Zylinska 2023)? Could art be the convex lens pressed against the concave lens of technology, to straighten out our view of the world and arrive at something that approximates truth? According to Heidegger, because art is in its essence much like technology it is one of the few tools which can provide a space for humans to encounter technology in the state of *Gelassenheit:*

> *Because the essence of technology is nothing technological, essential reflection upon technology and decisive confrontation with it must happen in a realm that is, on the one hand, akin to the essence of technology and, on the other, fundamentally different from it. Such a realm is art.* (Heidegger 1977, 35)

With such an approach, art is to play a crucial role in human interaction with technology. This raises questions about the role of the artist and the artist's relationship with technology which are explored in the next section.

3. The Artist as Observer in Time

The role of artists is manyfold, much debated and hotly contested. This paper turns to an anecdote told by Grayson Perry in the last of his four

1. Commonly translated into English as "releasement", however, this paper wishes to propose it as meaning "relaxedness", as a form of not caring too much.

Reith lectures for BBC Radio 4 given in 2013. The following is taken from the official transcript of said broadcast:

> *Recently a friend told me that she was working on an education programme at the Whitechapel Art Gallery and at the beginning of the project she asked the children…"What do you think a contemporary artist does?" And this very precocious child, probably from sort of Muswell Hill or somewhere like that (LAUGHTER), she put her hand up and she said, "They sit around in Starbucks and eat organic salad." (LAUGHTER) Now it was probably quite an accurate observation of many fashionable artists in East London, but I thought … you know anyway. So then after this, they spent some time looking at what contemporary artists did. And at the end of the project, she asked them again, "What now do you think an artist does?" And the same child, she said, "They notice things." And I thought wow, that's a really short, succinct definition of what an artist does. My job is to notice things.* (Perry 2013)

Before deducing what noticing has to do with consciousness, it is interesting to listen to what one of the most important painters of the 20th century noticed about appearance. In a private recording of a discussion with art critic David Sylvester in 1974, Francis Bacon reflects on the idea of appearance as follows:

> *And the way I try to bring appearance about makes one question all the time what appearance is at all. The longer you work, the more the mystery deepens of what appearance is, or how can what is called appearance be made in another medium. And it needs a sort of moment of magic to coagulate colour and form so that it gets the equivalent of appearance, the appearance that you see at any moment because so-called appearance is only riveted for one moment as that appearance. In a second you may blink your eyes or turn your head slightly, and you look again and the appearance has changed. I mean, appearance is like a continuously floating thing.* (Sylvester 2016, 136)

These two extensive quotes, separate as they may seem, demonstrate how two different artists grapple with the question of what it means to observe the world. What both statements show, is the role that conscious observation of the world plays in art. This also goes back to the difference between awareness and consciousness. One can be aware of the appearance of something but it is the noticing of it which constitutes the act of consciousness. Thus, it would be inconceivable that art could be created through mere awareness of one thing or another by an artist. The question then becomes what is the thing that is doing the observing? What is the human subjective "I" which is actively, consciously looking at the world and noticing things (Scruton 2001)? What becomes apparent in Bacon's statement is the role, that time and continuity play in art. Time is another strong link which connects art to the human contemplation of life and death and thus is part of the elements which give rise to our consciousness. After all, if time could not be felt by humans through bodily processes, maybe there would never have been such a thing as art. This raises questions concerning how machines may develop a relationship with time. Zylinska notes that "Time is what it (supposedly) is only for an observer whose life is grasped as a timeline; outside the (human) observer there is just change" (Zylinska 2023, 149). The intriguing question about this is whether once machines become

conscious, they will experience time. Or whether it will be the experience of time which will give rise to their consciousness? This research suggests that in any case, this would be manifested through art, which can be re-defined as consciousness made visible.

4. Sciences of Illusion

After having touched upon the role of time in art, it is worth dwelling on developments in Technology and their relationship with time. In an essay from 2007 entitled Aquinas and the Principle of Epistemic Disparity, philosopher Nicholas Rescher reflects on the fact that modern sciences seem to hit a limitation as to how much they can express through existing language:

> *Consider in this light the hopeless difficulties encountered nowadays in the popularization of physics—of trying to characterize the implications of quantum theory or relativistic cosmology into the subscientific language of everyday life. A classic obiter dictum of Niels Bohr's is relevant: "We must be clear that, when it comes to atoms, language can be used only as in poetry." And so, alas, we have to recognize that in philosophy, too, we are in the final analysis in something of the same position. In the history of culture, Homo sapiens began his quest for knowledge in the realm of poetry. And in the end, it seems that in basic respect we are destined to remain close to this starting point.* (Rescher 2007, 31)

This research proposes that Rescher's observations deduced from Bohr's quote are correct but wishes to extend them to the Heideggerian understanding of poiesis[2], meaning encompassing all forms of art rather than just poetry as it is understood in the contemporary sense. It is thus interesting to briefly touch upon one of those phenomena which challenge the scientific understanding of time. Like the fact that standard computers can more easily and accurately predict the future (Thompson et al. 2018). Humans take their ability to infer what happened in the past for granted but it is one of the abilities which sets humans apart even from the most advanced AI systems. Researchers in cognitive science and AI Gary Marcus and computer scientist Ernest Davis state that we need to "start building computer systems that from the moment of their assembly innately grasp three basic concepts: time, space and causality" (Marcus and Davis 2019). In 2018 a team of researchers demonstrated that what is known as the problem of causal asymmetry for standard computers, does not apply to quantum computers. What had been observed in the stochastic calculations was that "the memory required to predict the future differs from the memory required to retrodict the past" (Thompson et al. 2018, 1). The paper demonstrates how "Quantum models forced to run in the less natural temporal direction not only surpass their optimal classical counterparts but also any classical model running in reverse time" (Thompson et al. 2018, 1). A theory put forward in the 1990s by anesthesiologist Stuart Hameroff and Nobel prize-winning physicist Roger Penrose proposes that consciousness and quantum mechanics are causally linked. In Penrose's words: "Consciousness itself is a consequence of the collapse of the wave function" (FQxI 2023). Thus, it could be posited that awareness of time gives rise to consciousness. Without succumbing to speculation as to what this may entail exactly, it indicates if nothing else, that con-

2. From Greek, from poiēsis, a making (Collins Dictionary)

sciousness is intrinsically linked with time not only in a metaphysical, philosophical sense but also materially. The incertitude around these phenomena has given rise to a plethora of theories ranging from the claim that time is an illusion (Jaffe 2018), which would appear to contradict Einstein's theory of relativity, that consciousness is an illusion (*BBC News* 2017), to the idea that free will does not exist (Revell 2023). If all these concepts are indeed figments of our human imagination, the question arises as to why all humans share at least some notion of free will, time and consciousness. This paper claims that the advantage of art is that it has never been limited to physical reality but always crosses back and forth from imaginative realms to physical ones. This brings us back to Niels Bohr's intuition about the fact that certain phenomena of quantum physics are so abstract, that they can only be talked about in poetry. Therefore, this research suggests that the role of art as a phenomenon which is intrinsically connected to these concepts of free will, time and consciousness (which may or may not be an illusion) can today go beyond a mere antidote to technology as Heidegger may have seen it but provide insights which cannot be gained through other means of research.

5. Machines that Make Art

To understand how consciousness could be observed in machines, this paper wishes to adopt the understanding that creativity as defined by Margaret Boden is not necessarily needed to make art (Queyras 2023). This is why it is interesting to observe machines which operate on the edge of our understanding of art, creativity and therefore consciousness. A scribbly drawing by the art-making machine Méta-Matic No. 10 built by the artist Jean Tonguely in 1959, or a painting made by the computer programme AARON created by Harold Cohen in 1972 or indeed Ai-Da Robot created in 2019 by Aidan Meller and Engineered Arts may well be considered artworks (Queyras 2023). As previously stated, this paper does not address the question of whether machines can make art but what we can learn from machine-made art in the wake of discoveries in various scientific fields, from physics and biology to philosophy. The task which this paper suggests is worth undertaking is looking at these artworks as archaeologists would for traces of consciousness.

In his 2019 book, *The Creativity Code* Mathematician Marcus du Sautoy writes:

> *Wittgenstein wrote: "If a lion could talk, we would not understand him." The same applies to machines. If they become conscious, it's unlikely to be a form of consciousness that humans will initially understand. Ultimately it will be their paintings, their music, their novels, their creative output, even their mathematics that will give us any chance to crack the machine's code and feel what it's like to be a machine.* (Du Sautoy 2019, 287)

This research claims that the emphasis on creativity for the making of art is a reductive idea which gave rise to the commonly accepted premise that AI is needed for a machine to create art. Artworks however machinic they are and no matter whether they are powered by AI, have always entailed a human participant, just as human-made art has always involved some non-human elements (Queyras 2023). This research echoes the fundamental premise articulated by Brian Reffin

Smith: “A good idea will be good even if realised on a cheap computer, using a bad printer, monitor or graph-plotter as output. A bad idea will remain bad, even when portrayed on a million-colour ultra-high-resolution display” (Smith 1989, 41). The same may be true of consciousness. Thus, this paper shares the view that more computational power is not what will allow machines to make art which could communicate a form of consciousness. Art comes forth through conscious observation of the world and the aspect of *noticing* has so far always been performed by humans in conjunction with machines.

From machine learning systems, Generative Adversarial Networks (GANs) and Creative Adversarial Networks (CANs), to systems like Chat GPT and other language models, the premise still rings true that more data means more possible outcomes and more computational power means easier exploitability. Thus, this paper claims that machine learning in and of itself is not a task which brings the machine closer to consciousness. More knowledge, more data and more mathematical power are not going to lead to an emergence of consciousness. While research into human consciousness is not conclusive about when it begins in humans, the possible timeframe in which it may emerge ranges from 35 weeks after conception, still in the womb, while the most radical views propose that it does not emerge before 3 years after birth (‘When Do Humans Become Conscious — in the Womb or after Birth?’ 2023). However late consciousness may emerge in humans, it likely does so long before extensive knowledge of this world is gathered by our brains (Tiemeier et al. 2010). Considering the gap between computability and consciousness, this research suggests that a renewed philosophical confrontation is needed concerning how we “teach” machines how to learn. The emergence of consciousness in humans has been central to ethical debates around political issues and this paper suggests that it is no different if ethical considerations are to be made about machines.

Conclusion

This paper concludes by suggesting that although we do not know what consciousness is, while we have a concept of time which is highly counterintuitive and evolving, at the crossroads of these phenomena humans place their mark which shines a light on their conscious existence in the world, which places them in a moment in time. Today, humans collectively call this mark *art*. The question which is still open is do machines do the same? This paper suggests that it is not by using machines and AI to make more tools that we will find those traces but that it is a form of art which can bring forth traces of consciousness from the machine. This research reframes art as a revelatory element (like light) which brings forth or makes visible the invisible. Thus, this research does not claim that art tells us how consciousness works or where it resides but that it makes it visible. And therefore, art is for us the revelatory tool which at least *shows that consciousness exists* in one form or another.

Glendinning puts Heidegger’s point of view as follows: “Humans are *actual* (being different being outside) only insofar as we dwell poetically” (Glendinning 2016). Considering the advancements in neuroscience, the advancements in physics and quantum physics (including all the shakeups which have destabilised those disciplines), the post-humanist perspectives which have entered the marketplace of ideas and finally, considering the technological advancements in many fields including

but not limited to artificial intelligence, this research suggests that Heidegger's claims are no less actual than they were in the 1950s and that they can be useful if re-examined in a contemporary 21st-century context. This research postulates that art does not redeem humans. However, art has the capacity to provide transparency and is a formidable investigative tool. Through art, we see aspects of ontological truth which are otherwise inaccessible to us. In other words, we make ourselves aware of our consciousness through art. The transparency and lucidity which can be provided by art could be what arguably gives us free will after all. By seeing the world and being aware of our consciousness, we can make choices. A purely artless world would be a world without traces of consciousness, and thus one where the possibility of free will could not be explored. Art, however, creates the world, the space in which free will can potentially subsist. Thus, art may be our only tool to observe consciousness in the world be it in other humans or machines.

Finally, this paper claims that over the last two decades, art has entered a decisive new phase. Its collective understanding from artists, to curators to the public has shifted from a phenomenology of cultural generation to a phenomenon in which through observation, humans can and may one day *notice* traces of consciousness which do not originate from a fellow human being.

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Exploring CyArk: Needs, Novelties, and Dilemmas

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This paper explores the burgeoning digitization of public heritage, focusing on its ethical quandaries by examining CyArk, a prominent platform dedicated to digitally preserving cultural heritage. The paper delves into CyArk's inception, its mission, and its evolving role in the digital preservation landscape. It scrutinizes CyArk's methodology, particularly concerning ownership of 3D model data, language representation, and community involvement. Drawing on post-colonial discourse, it critiques CyArk's approach and proposes improvements for a more inclusive and ethically grounded digitization process. The reflection section offers insights on community engagement, language inclusivity, enhancing interactivity, transparency, and embracing immersive technologies. The research advocates for a nuanced and ethically informed approach to heritage digitization, urging CyArk and similar platforms to address concerns and foster greater inclusivity in preserving global heritage digitally.

1. Introduction

Lately, there has been exponential growth in the digitization of public heritage, bringing exciting new opportunities. Still, it also, like other technologies, comes wrapped with ethical challenges (Manžuch 2017). The rebuilding of Notre Dame using Building Information Modeling (BMI) is an excellent example of what digitization of public heritage could mean for the future. ("Rebuilding Notre-Dame de Paris Cathedral | Autodesk" n.d.) As in the words of the famous English novelist George Orwell, "Who controls the past controls the future. Who controls the present controls the past."(Dubois & Roduit 2019) The advancement of information technologies coupled with the digitization of heritage has a multidimensional impact on the protection, consumption, and education aspects of public heritage. However, exploring what best practices exist and how to avoid ethical challenges within this field is crucial. I will connect these thoughts through the tool I aim to review for this paper, CyArk. ("CyArk" n.d.)

Founded in 2003, CyArk's mission is to preserve and curate the shared cultural heritage with statistics, emotions, and cross-platform support. With hundreds of models readily available from the platform, it offers a guided experience of heritage sites from the Americas to Asia. Further details on the platform's operability and the thought process behind it are shared later. CyArk has emerged as a critical player in heritage digitization, which it makes possible through its historical ground-breaking work, evolving vision, and institutional partners. The application of CyArk's work is not limited to digital screens, but it has

Keywords Digital Heritage, Post-colonialism, Digital Representation, Digital Culture, Digitization.
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provided valuable inputs when the heritage sites were destroyed or were on the verge of it (Addley 2019). CyArk's CEO expressed his faith in the tool to re-construct lost heritage with digital scanning and data points. Through this, one could quickly establish that CyArk is a revolutionary platform that educates its users online and provides real-time data that can enable engineers to rebuild a site with precision. On the other hand, it opens a series of ethical and moral questions. Why is CyArk documenting the heritage sites globally? What will be the commercial value of their work in a born-digital age? What methodologies do the works follow? Who owns the data points of public heritage sites? The remainder of the short paper will answer these and other connected questions.

As exciting as the work of CyArk seems, tools, when used by humans, are not neutral (Markoff 2006). They are shaped or dictated by how humans may wish to use them. The digitization work by CyArk needs to be further peeled off using ethical methodologies to understand the ambitions, needs, novelties, and dilemmas. The human-technology relationship can explain the co-evolution of the users and the tools (Jouhki & Hurme 2017) if we establish that tools are not neutral and their users shape them. There is an inherent bias in which they operate; we can also, for example, establish a hypothesis that CyArk's work is not neutral. As the work of CyArk is also based in countries that were once colonized, it is only fitting that I guide my analysis through post-colonial theory. Post-colonial theory goes at length to explain the key characteristics of framing a narrative that brings equity. Still, for the paper's relevance, I will pick three main features for the argument (Léglise & Migge 2007). First, colonial powers have historically captured materials for use, making exploitation the center of the discourse. Secondly, they have perpetrated their language and culture as ethically and morally better. Thirdly, colonialism's moral grounding was leveled into the greater good or happiness of the world. There is another concept that will help me in connecting my thoughts, and that is what Harold Schiller coined as "Electronic Colonialism." Schiller described it as the ability of electronically advanced countries to use the mediums and propagate their views and discard the needs of marginalized groups (Schiller 1975).

CyArk, which started as an archive to document the endangered world heritage sites (see Figure 1), has evolved into an open-source platform to document heritage and foster a community where this dialogue is further shared and nurtured. By collaborating with initiatives such as Open Heritage 3D ("Open Heritage 3D | About" n.d.), CyArk is one of the front-runners that makes heritage digitization as open data accessible and readable for other stakeholders. It has further delved into documenting historical events, thus expanding its scope and thus also incorporating intangible heritage as part of its platform. The works are segmented into various categories; a few of them are Sacred places, Journey to equal rights, Places of worship, United States history, and others. Over the years, it has expanded into a storytelling platform, connecting with audiences who wish to understand and work with existing 3D models.

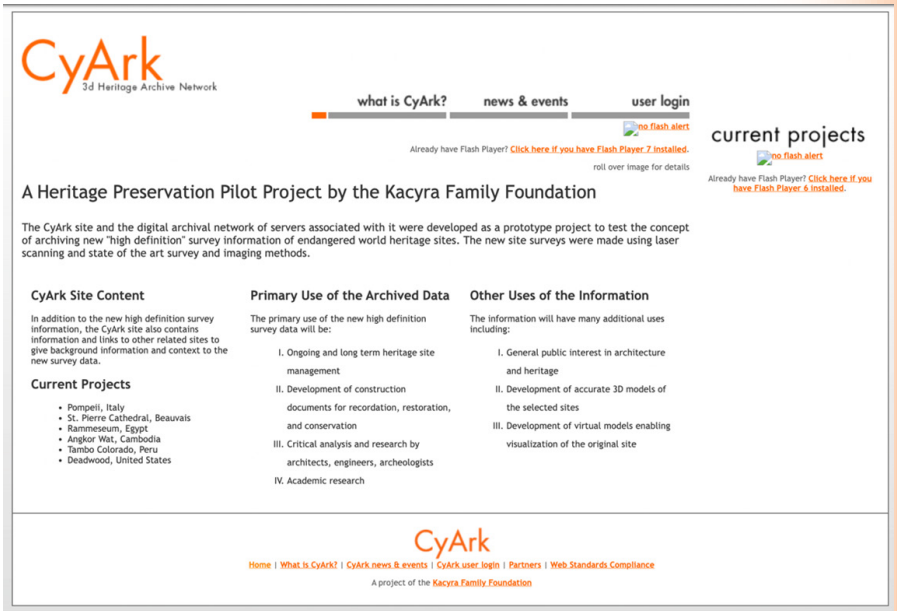

Fig. 1. Image of CyArk taken through Wayback Machine for the date 06 December 2004. Source: https://web.archive.org/web/20041206142350/https://www.cyark.org/

CyArk's work is commendable, exciting, and innovative, considering our world is on fire with polycrisis, especially with climate change and religious extremism, the heritage sites are at a greater risk than ever before (Vyshkvarkova & Sukhonos 2023). Such events have accelerated the need to adapt and understand digital public heritage. Within the last decade or so, we have also seen the devastating impacts of religious extremism on cultural sites. In 2015, ISIS destroyed some of the key heritage sites in Iraq and Syria, evoking a global response from digital heritage professionals to re-create, preserve, and fight the extremist ideology (Michelle Starr 2015). Now CyArk is not alone — several other tools and institutions are working to digitize the heritage, such as Smithsonian, The Institute for Digital Archaeology, Three D Scans, Carare, Europeana, Iconem, and others. As a researcher, this gives a solid grounding to further examine CyArk for what works and what does not. I will use the opportunity to employ comparative analysis to examine further the highlights, the limitations, and how it can improve its operability, technicalities, experiences, and user interaction.

2. Methodology

By establishing the Universality of heritage preservation and using terms such as "collective" and "shared," UNESCO has divided the burden and urgency of preservation among us ("Culture | UNESCO," n.d.). The "novel" mission is taken up by various organizations, using various tools and techniques such as but not limited to 3D modeling, photogrammetry, videography, and algorithmic projections. The idea of digital preservation has evolved in its scope and meaning. Thanks to interactive technologies, the heritage sites at risk can be digitally recreated and, in other instances, printed as well (Blahut 2016). The trends of digitizing go as back as early as the 1970s when various audio-visual techniques were involved in the documentation of the heritage (Wang et al. 2020). However, what does it mean for the heritage to be Universal? How do different organizations explore this concept? What fundamental ethical challenges lie within such a thought process?

The earlier version of CyArk's website (see Figure 1) presents itself as a heritage archive or a database. As you see the platform's evolution over time (see Figure 2) word "saving cultural heritage" becomes the center of it. Novelty is added to the tool's mission, giving it a greater acceptance that it is worth saving the heritage for future generations. The grounding of CyArk's work is deeply rooted in Western Utilitarianism for greater happiness. So, in its true sense. CyArk believes in Universality and a Utilitarian way of working. In his TED Talk, the founder, Ben Kacyra, mentions his helplessness when the Bamyan Buddhas were destroyed in Afghanistan, so he founded CyArk to digitize heritage sites for future generations (TED 2011). The surface morality behind it is worth praising, but it opens a series of ethical and moral dilemmas. What is the motivation of CyArk to document the sites at risk? Which heritage sites are shortlisted and why? What becomes of the 3D data points? Who owns them? What is the involvement and ownership of the local communities? Who gets the credit? What partners are financing such works, and what are their ambitions behind them? These and similar connected questions will aid in understanding the methodological grounding of the tool.

Fig. 2. Image of CyArk taken by Wayback Machine dated 11 May 2009. Source: https://web.archive.org/web/20090511012716/http://archive.cyark.org/

I agree that CyArk's being pioneers of digital heritage has come a long way. However, it has layers of electronic colonialism, which Morehshin Allahyari, an Iranian-American artist, puts as information technologies that embody colonial fragments (Allahyari 2020). To establish my case, I will compare two works from the same region and try to put my argument through a comparative analysis. The first work is from CyArk, Lamassu (from the British Museum), and the other is The Distributed Monument by Morehshin Allahyari ("CyArk Projects: Assyrian Collection of the British Museum" n.d.; "The Distributed Monument" 2016).

The digital representations of both models are accessible online for audiences to interact and explore. However, only Allahyari makes the corresponding communication, source files, and credits readily available online. By doing so, Allahyari is re-writing how 3D models of public heritage objects should be for everyone. At the start of the paper, I mentioned three characteristics to examine works through a post-colonial framework: material control, linguistics, and the greater good. I will use this critical point of departure to put forward my case and establish that CyArk needs to improve its methodological grounding as there are currently ethical challenges encapsulated with its work.

2.1. Who owns the 3D model data?

Let us start with the 3D data and source files. CyArk states they can share the project's source files for non-commercial and educational purposes. By enabling this, they suggest a creative common usage of the data sets. In the future, if the models are required to be printed for commercial use by the local Chilean institutions, would they need to pay CyArk? How can one institution trademark data sets of public heritage sites for digital distribution? These questions of ownership are inspired by the conversation of traditional museums returning their looted artifacts to their country of origin (Daniels 2020). The knowledge and datasets acquired by CyArk have financial and material significance that should be shared with the local cultural institutions whose heritage is in question. So, let us revisit this, and in the words of the Allahyari, the Western institutions digitizing the heritage of emerging countries is similar to museums keeping the artifacts in their collections and benefiting from it (Rhizome 2019). The mediums have changed, but the power dynamics are effectively unchanged.

2.2. What languages are used and why?

Language remains a tool of colonialism (Sayeh Sayedayn 2021). Language also depicts who are the intended audience of the project. Who is it designed for? Who are the primary and secondary stakeholders? Who gets to access it? Almost all the CyArk works are digitized and presented in English. Is it done for its Global North audiences? Why doesn't the model include the local language of the heritage sites? Which heritage sites are picked and why? Does it rely on public and media sensations? These questions can help further navigate the reasoning behind the choice of language in the presentation. For CyArk, most of the work is driven by English-speaking audiences in the West. For the 3D model to be more inclusive, it should have an option for local language translation so the people whose heritage is in question can understand how it is presented and why. This language barrier propagates social injustice, moral hierarchy, and cultural alienation that are remanent of a colonial legacy (Heller & McElhinny 2017). In contrast, when Allahyari's work is on display, it features a USB that documents her project in English, Arabic, and Persian, the languages of the communities on which her work is based.

2.3 What about the community in question?

The questions centering on the community are around finances, labor, and ownership. In her take on heritage digitization, Sarah Bond asks if the local communities should get a share of the donations or earnings raised through the 3D modeling of their heritage sites (Bond n.d.). Should the local communities and partners get explicit mention of their work? As Matthew E. Davis points out in his work, even a simple digitization of an image is much work and requires several steps (Davis 2018, 106). There must be actors involved beyond a single entity. These ideas are also connected with labor ethics and the invisible workforce that makes digitization possible (Smith & Whearty 2023). Would the local community co-share the ownership of the digitized works? At present CyArk website only mentions the institutional partners that it works with. It also lacks a clear framework of what becomes of the digital pieces once digitized and how much contribution remains from the community whose heritage is in question.

The above questions' presentation and further analysis with CyArk and other tools can help us establish their work's lack of ethical grounding. CyArk work has successfully tapped into one urgency of present times: to save our heritage. In doing so, it is playing at the hands of what Allahyari terms digital colonialism. With careful deliberations and addressing the needs of a post-colonial framework, CyArk's work grounding methodology should be improved to make it more inclusive. To put it more vividly, it is not a one process but a continuous collaborative dialogue that needs to happen with the institution working in digitization, the community in question, and other relevant stakeholders.

3. Technicality

CyArk has delivered works in diverse geographics, making them a critical digital heritage player. The platform has evolved to cater to technological advancement and user needs. In this section, I will examine the platform through a series of questions, including: What are the critical features of CyArk? How does it work? Where is it lacking? How does the overall user experience of the tool perform as per the industry standards? How can it be improved in comparison with other similar tools?

CyArk offers web and mobile-based solutions through its website and additional curated experiences through its portal called Tapestry ("Tapestry - 3D Virtual Tours," n.d.). At first glance, it is easy to navigate; in the projects section of the website, you can explore various projects individually or through curated collections. Each project is represented through a webpage containing descriptions, locations, and further characteristics such as 3D virtual tours (through tapestry) and lesson plans. A few other projects also include 3D models that can be accessed through Virtual Reality equipment. It adds another layer of immersive experience. In terms of the user experience, the website and platform are designed for an average Internet user with an understanding of basic website browsing and the English language. The key features of CyArk include free access, source data files available for non-commercial use, curated tours, and immersive experiences through virtual reality. In terms of Sustainability, CyArk's platform has been there for more

than 20 years, which is a testament to the seriousness of the work carried out by the institution.

The platform's working is simple; a user can explore through a series of projects. Once on the selected project, you can sit back and toggle through various scene controls. In a few instances, the platform also features local voices and additional imagery with the heritage site, adding another interaction layer. I will analyze CyArk user experience through interactivity, accessibility, operability, and customization.

One of the platform's limitations is the inability of the user to customize the 3D model further and play around with its characteristics. For example, Iconmen allows users to play with the display appearance ("Iconem Platform - Murad Khane District - Kabul," n.d.), cameras, perspective, and other settings. It also allows users to make measurements and GPS coordinates with the existing model, adding a layer of interactivity that seems missing from CyArk (see Figure 3). The information on CyArk's display is quite polished and well-curated. If you are a user interested in the data and what imagery has contributed to the 3D model, CyArk has limited representation. Specific models on display through Icnonem's website have captured media files that give an instant idea of the working files and data behind the digital representation.

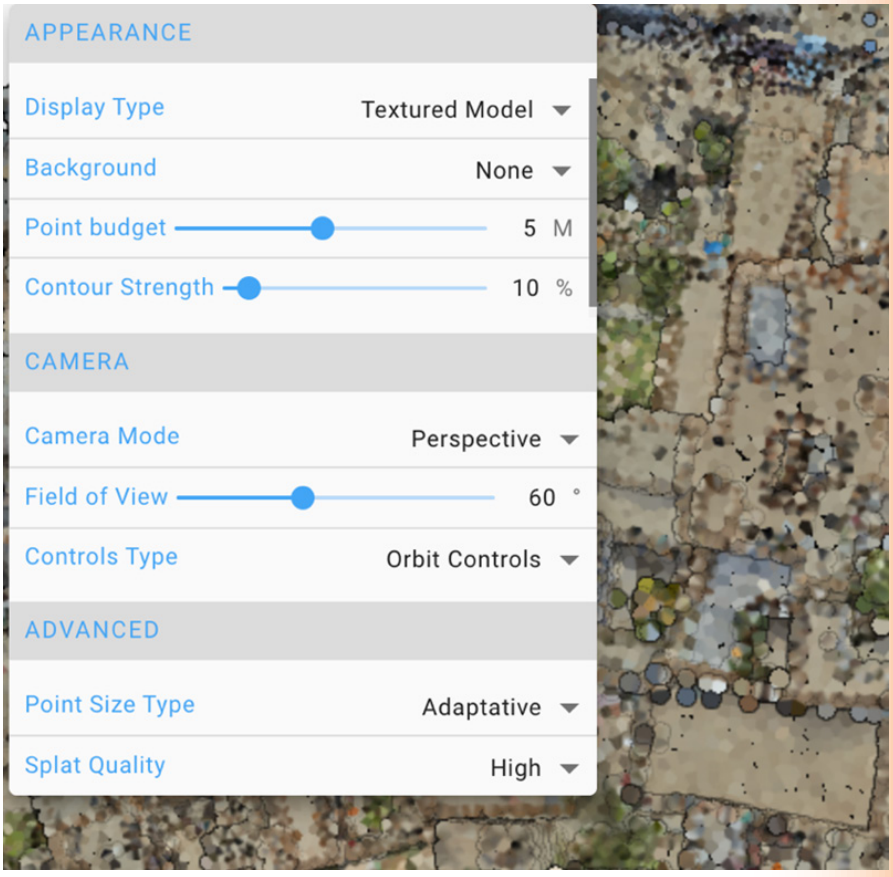

Fig. 3. screenshot from Icnonem's website that allows further characteristics manipulation. Source: https://app.iconem.com/

Regarding accessibility, the models and their associated data are only available for non-commercial use. The grounding of this was discussed in the first section. However, CyArk can learn from projects such as Three-D-Scans, where 3D models and associated data have no limitation use ("Three D Scans" n.d.). CyArk does not allow its users to embed the 3D models publicly to the third-party website, which reduces its external application. For example, Sketchfab allows the models hosted

on its website to be embeddable on other platforms and websites, which enhances the visibility of public works to appear on various other web pages (“Sketchfab – The Best 3D Viewer on the Web” n.d.). Another critical feature missing from CyArk’s website is allowing users to download or print the 3D model directly from the platform. The platform suggests its users get in touch for access under Creative Commons. In comparison, the tool Smithsonian, still restricted under Creative Commons, allows its users to download the model directly without requesting access (see Figure 4) (“3D Digitization | Smithsonian” n.d.). Also, the tool Global Digital Heritage allows its models to be downloaded directly through Sktechfab (Roman Temple of Evora – Download Free 3D Model by Global Digital Heritage and GDH-Afrika – Sketchfab, *n.d.*). This removes a layer of bureaucracy that allows users to delve further into the 3D model and its characteristics. Currently, the models are only presented in English, but incorporating the local languages of the digitized sites can further improve user access. Imagine having Spanish, French, Arabic, and other languages, making the platform more inclusive and increasing its overall application.

Another key feature that can increase the user’s overall experience would be saving and retaining their experiences on the website. The platform could also be further improved by allowing users to create an account and populate the model with key findings, thoughts, and crowdfunded information. This will enable audiences to take further interest in the overall story of the works, and by having the possibility to connect with other interest groups, it can increase its application.

Fig. 4. Screenshot from Smithsonian that allows direct download of the models. Source: https://www.si.edu/object/3d/orbiter-space-shuttle-ov-103-discovery:d8c636ce-4ebc-11ea-b77f-2e728ce88125

4. Reflections

By using the methodological and technical grounding that was presented in the previous sections, here are a few reflections that will help me place CyArk’s work in a post-colonial digital humanities world:

1. The ethical discourse on digitizing heritage is pretty novice, but it is a direction where the future models should be headed. If CyArk wishes to continue digitizing public heritage, it should think beyond saving heritage and encapsulate the post-colonial discourse in its models. This can be done vis-à-vis greater collaboration, transparency, co-ownership, and representation of the local communities. In her project Memory Matrix, Azra Aksamija at the MIT Media Lab presents a collaborative

way of understanding what is lost and what is to be preserved by having community input (“Memory Matrix – Fragment Azra Aksamija” n.d.).

2. The choice of language is essential in the discussion – if CyArk believes its models are for the greater good of the communities in question. It should incorporate the language of the communities in question and examine the wide-ranging relationship between the languages, colonialism, and digitization of public heritage. An example of the Te Papa Museum providing Māori language transcription as part of the overall website could be seen as one guiding example (“Home | Te Papa” n.d.).

3. The tool provides a great starting point for the audiences to interact with the heritage sites, but in terms of interaction, it is what Edmonds would term as a static model (Edmonds, Turner, and Candy 2004). For a model to be truly interactive, it should allow audiences to interact with it at a symmetrical communication level (Schultz 2000). CyArk only offers a pre-defined journey curated by the platform. Suppose users can create accounts, leave comments, add imagery, and further modify the models. In that case, the digital model’s story will be rewritten by each user and will induce interactivity at a greater level. An example of Plateau Peoples’ Web Portal where the indigenous community is updating the collection records by the additional context of the imagery. Washington State University’s (WSU’s) record mentioned one photograph as “3 Yakama Women in Regalia (1911).” As the web portal allowed contributions from the community, it enriched its content and enabled more comprehensive discussion on muti-contexts of a curation (Christen 2018).

4. Keeping a tool servicing for more than 20 years deserves appreciation on its own. The sustainability of any tool or platform is challenging, but CyArk lives up to it. Further improvements can be made by more transparency on the labor angle of their work. By including the names of the contributors, it can minimize the ethical challenges that surround this aspect.

5. CyArk currently offers the virtual reality (VR) mode for some of its models. Being the industry leaders, other techniques of immersive technologies could be offered, especially with the mainstreaming of Quest, Holo-Lens, and other similar tools that can provide users with better storytelling experiences. 1RIC studio is one example of using people’s intangible experiences to generate highly interactive holograms and games, allowing users to walk through a digitized work (1RIC 2018).

We live in a rapidly advancing world of data; its value and power relationship are significant in society. CyArk and other digital heritage tools have an ethical and moral responsibility to consider the challenges that arise from their work. If the public digital heritage models are monetized, data points are not public knowledge, and local communities’ voices are not represented. It is Disneyfication; it is theatrics, but it is not heritage in its actuality.

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Bestiarium Memeticum

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Building on my previous research on internet memes from a critical posthumanist perspective, the *Bestiarium Memeticum* presents a collaborative-based understanding of memetic evolution reimagined through the framework of a medieval bestiary. Memes, defined as vital assemblages that interweave users, platforms, and online customs, are reinterpreted through the lens of mythology, enriching conventional descriptive analyses with reflections on their ethical and poetic dimensions. The *Bestiarium Memeticum* serves as a tool that not only foregrounds non-human agencies, but also offers a whimsical yet insightful exploration of ambiguous phenomena such as exploitables, copypastas, viral audios, algospeak, Wojak, the Girl Online, AI cryptids, and online cults. This allegorical account not only expands the understanding of digital cultures, but also promotes a nuanced understanding of the memetic forces at play, revealing how modern myths define and contest the realms of knowledge and power in the digital age. This approach reveals the transformative power of these narratives, reshaping how we understand collective human and non-human interactions in the entanglement of offline and online entities.

1. Introduction

Lo and behold, weary traveller of the wire, and read about the legendary creatures inhabiting the cybernetic realm in this *Bestiarium Memeticum*. Fabricated in the great tapestry of binary code, these beasts have emerged from the digital depths of communities where avatars built from copper and silicon eke out an existence. Some are common occurrences, while others are as rare as the fabled unicorn's ethereal presence in moonlit glades.

A bestiary was a medieval guidebook containing descriptions and allegories of animals, beasts, and mythical creatures that were illustrated with intricate illuminations. In addition to formal descriptions of their appearance and whereabouts, bestiaries typically interpreted the beasts allegorically, for example, phoenixes were seen as a symbol of resurrection and eternal life, a lamb represents Jesus Christ, and foxes were said to be deceptive. The widespread use of bestiaries as animal lexicons among artists and writers shaped the associations that persist in modern culture. This project revives the tradition of the conflation of ethics and biology in medieval bestiaries and connects it to the principles of critical posthumanism in regard to digital entities. By examining how internet memes also reflect on the form of bestiaries in regard to the entanglement of image and text, this *Bestiarium Memeticum* seeks

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to illuminate the trajectories of digital phenomena by drawing parallels that bridge centuries of magical thinking.

2. The Medieval Bestiary as a Tool for Exploring Digital Cultures

2.1. Motivations for Creating Bestiaries

There are numerous reasons why a medieval bestiary is a suitable format for studying internet memes: first, the understanding of memes as living creatures in the sense of vital materialism, a framework that perceives all matter as agentially active and dynamic. (Bennett 2010) Rather than defining memes as sole means of communication or digital items, (Shifman 2014, 7-8) I understand them as living assemblages that unite users, platforms, technologies, and cultural manners. In this respect, memes can emerge, mutate, and ultimately die or go extinct, analogous to biological organisms. On the one hand, such an interpretation ties in with the discourses of memetics and co-evolution, recalling that the term meme was coined in analogy to a gene. (Dawkins 1990, 176) Contrasting with the competitive evolutionary model proposed by Dawkins, Lynn Margulis' endosymbiotic theory suggests that evolution is driven by collaboration, not rivalry. This *sympoietic* approach is particularly relevant to memes, which thrive not through individual survival but through the collaborative processes of sharing, adaptation, and remixing within online communities: "In certain cases cohabitation, long-term living, results in symbiogenesis: the appearance of new bodies, new organs, new species. In short, I believe that most evolutionary novelty arose, and still arises, directly from symbiosis." (Margulis 1999, 33) In this respect, collaboration or the continuous interchange between properties, users, references, etc., is always present in a sympoietic interpretation and provides the inherent logic on which every meme is based. Donna Haraway goes even further and proclaims that monsters provide the possibility "for building new collectives out of what is not quite a plethora of human and unhuman actors." (Haraway 1999, 327)

Secondly, the bestiary aligns with posthumanist goals which challenge the traditional human-centric view of the world. The Anthropocene as a critique of humans as the summit of creation, which gave way to the Western binary conception of nature versus culture, has led to an increased interest in vibrant processes and entangled systems. By examining memes as assemblages that transcend individualism, this work contributes to broader discussions on the codependence of humans and their digital creations. One step in the direction of a posthumanist future is therefore a remediation of life as a material, formative force that permeates everything instead of an attribute to acquire. For a long time, such an understanding was labeled holistic and esoteric, a prejudice based more on a blind spot towards the rationalist ideology of many evolutionary biological processes than a substantive critique of systemic models. (Haraway 1997, 133) Additionally, it should be emphasized that sympoietic processes are defined as lacking "self-defined spatial or temporal boundaries" (Dempster 2000) and by no means as neatly closed systems. In this respect, the posthumanist perspective is a shift that not only understands itself as part of a living system, but also

explores its own agency in relation to the various existing virtualities of agency.

The third and decisive reason for creating a bestiary lies in the potential of a playful understanding of magic and mythology. When cerebral explanations of a phenomenon are not sufficient, inexplicable processes are often naturalized or understood as magical. However, this attribution of certain functions does not mean that they are not explored: the bestiary entries outdo descriptive analyses of specific online occurrences by interpreting them through a lens of speculation. The rhetorical undertone of the bestiary manifests as a whimsical exploration of all that is rendered invisible online: fake news and media literacy, material conditions of information technologies, the discerning of opaque political or economic motives, automated censorship, humor, cultural gestures or customs, layers of irony, and so on. In this regard, it stands as a venture into the potential agencies arising from incomplete knowledge within an era of algorithmic control. This also corresponds to what Sigmund Freud identified as *das Unheimliche* ("the uncanny") that he traced back to a movement of repetition:

> *Das Moment der Wiederholung des Gleichartigen wird als Quelle des unheimlichen Gefühls vielleicht nicht bei jedermann Anerkennung finden. Nach meinen Beobachtungen ruft es unter gewissen Bedingungen und in Kombination mit bestimmten Umständen unzweifelhaft ein solches Gefühl hervor, das überdies an die Hilflosigkeit mancher Traumzustände mahnt. (Freud 1947, 249)*

The mere act of repeating or doubling something—the logic of mimicry—marks the origin of the uncanny as is shown in Freud's discussion of the figure of the *Doppelgänger*. Processes of repetition and imitation are therefore not just the premise for most memes, but correspond to the theory of sympoietic evolution, too. Following up on Freud, Mark Fisher employs the concept of the uncanny in order to investigate the allure of the weird and the eerie or the horrors that peek into the inside from the outside. Where Freud interprets the uncanny as a primal fear stemming from the depths of the unconscious, subsuming to castration anxiety, Fisher declares the weird as a fear creeping inside that "does not belong." (Fisher 2016, 10) Weird phenomena such as the juxtaposition of contrasting references and temporalities as well as techniques of alienation, e.g. deep frying, occur repeatedly in internet memes, whereby even seemingly familiar images are distorted and estranged. In contrast, the eerie's sensation appears "when there is something present where there should be nothing, or is [sic] there is nothing present when there should be something." (Fisher 2016, 61) This feeling is also triggered by memes reflecting on unseen anxieties of the collective unconscious or the legendary control mechanisms of recommendation algorithms, while the process of memes losing ties with their original context can be labelled as eerie. Most interestingly in relation to memetic techniques, Fisher writes: "The form that is perhaps most appropriate to the weird is montage—the conjoining of two or more things which do not belong together." (Fisher 2016, 11) That which has been separate coming-together also reaffirms the logic of sympoiesis. This is why the bestiary is an appropriate form of analysis: memes are not merely transient cultural artifacts; they are dynamic expressions of collective experiences that echo the complex interplay of fear, creativity, and alienation. In this

regard, internet memes function as modern manifestations of age-old narrative techniques—reshaping how we understand ourselves and our collective psyche.

2.2. Methodology

While there can be no rigid definition of what counts as a beast and what does not, I identify processes and techniques underlying sympoiesis as memes. This means that the process of creating and sharing exploitables is just as memetic as any given example created of these techniques. I settled for eight examples of popular memes and memetic techniques that represent a spectrum of digital entities that have influenced the dynamics of online eco-systems over the last 30 years to be discussed in the bestiary: exploitables, copypastas, viral audios, algospeak, *Wojak*, the Girl Online, and online cults. Of course, as new memes and digital phenomena emerge over time in regard to potential new platforms or ways of coming-together online, the bestiary may continuously be expanded upon. The bestiary builds upon the qualitative research conducted in my dissertation, *The Sympoietic Life of Internet Memes*, (Publig 2023) that features a thirty-year-long genealogy of digital memes since 1993. In an approach that could be described as memeing the dissertation, its results are generatively extended by the media-specific character of the bestiary, whose medieval language was dynamically recreated through the iterative use of AI-driven text generation tools. This process involved continuously rewriting the text to integrate medieval proverbs, pig Latin, and references to ancient myths and texts, achieving a novel way of expression that also mirrors the evolving nature of memes. This iterative interaction between computational tools and medieval text forms demonstrates the hybridity of the digital creatures explored in the bestiary, reflecting the constant transformation and adaptation of memetic evolution.

3. Bestiarium Memeticum

3.1. *Imago explotabilis*

In the digital tapestry, behold the *imago explotabilis* or exploitable, that verily lends itself to the craft of memery, by virtue of its glee, folly, shock value or ability to kindle strong emotions. Exploitables manifest in forms manifold, be they official likenesses such as stock portraits, candid snapshots, selfies, or scenes from the stage; or be they ekphrases, sketches, screenshots, illustrated scrolls, webcomics, or other such renderings. The moniker ‘exploitable’ may stem from the gaze of users, who, like alchemists, transmute base visuals into digital gold, viewing these images through an extractive lens, seeking to infuse them with deeper layers of meaning through manipulation, much as the earth yields precious ores to those who know where to dig. This may be wrought by the addition of textual inscriptions, an art known as object labelling, or by crossing out and rewriting existing text upon the image, akin to the parchment upon which a manuscript hath been overwritten. Like the griffin, guardian of divine mysteries, morphs from lion to eagle, so too doth the *imago exploitabilis* shift form, a chimera of ever-changing digital bits. Of special note among exploitables are image macros, those favored tools of the classical memery from the twilight years of the two thousands, which

are marked by the sacred trifecta of image, text, and layout: whereupon the image oft features a character, such as those found in the scrolls of *Advice Animals*, the interplay between the text above and below being vital in delivering the jest or punchline. Thusly, all image macros are exploitables, yet not all exploitables adopt the distinctive layout of the image macro. Another breed of creature are multi-panel exploitables, unfolding as if panels in a diptych, which oft manifest as bifurcated tables for the text and image, operating according to the logic of favor or disfavor, as in the case of *Drakeposting*. Such multi-panel exploitables may also embody an internal progressive logic, as seen in the case of *Galaxy Brain*, mapping the ascent of thought from earthly to celestial. Sometimes it is also visages from yesteryears that resurrect as exploitables, bearing silent witness to eras faded. Consider the painting *The Accolade* by master Edmund Blair Leighton, although no longer a tableau of chivalry, yet in the modern court of the close friends list, it serves as a knightly honor bestowed.

Fig. 1. The Accolade

As creatures mostly shared between common folk in their daily dealings, these exploitables are heralded by virtue of their ready-made quality. In this guise, exploitables embody the qualities of the poor image, of declining quality through much sharing upon the networks of social media, as Hito Steyerl hath noted: “It is a specter of an image, a

foretaste, a miniature, a wandering idea, a transient image dispersed freely, squeezed through sluggish digital conduits, compressed, replicated, torn, remixed, and even copied and pasted into other channels of dissemination." (Steyerl 2009) Most exploitables doth possess an inherent humor, yet they become saturated with the distinct pleasures and narratives of a particular group through the process of memeing. Their primary mission thus unfolds to foster a sense of community through their relatability, which oft spawns a multitude of mutations should the exploitable gain viral renown beyond its native digital shores.

3.2. *Effingo Pastae*

Verily, *effingo pastae* or copypastas are lengthy texts used as palimpsests, overwriting posts on message boards and social media. Born from the magical commands of copy and paste, the copypasta emerges as a phenomenon birthed by the functions of modern machinery; it doth allow to post long verses without typing them out letter by letter. Much like the plight of the nymph Echo, who was cursed to repeat only the final words spoken unto her and possessed not a voice of her own, copypastas initiate an endless loop of repetition and recursion. Employed as a rhetorical technique, copypastas are oft used to disrupt board communication or to vex and overwhelm novices. Essentially, they serve as an easy way to dominate discourse though the art of being a pain in the neck toward other folk—some copypastas are so lengthy, one must scroll for ages to reach the next commentary. Observe how this technique hath its roots in the ancient forms of online communications such as message boards or newsgroups that did not have a 'hide comment' feature yet, much less a real-time transmission of such notes. Though some might argue that copypastas find their genesis in electronic mail chain letters and spam messages, the latter are mostly distributed via bots or scammers whilst the former are exclusively shared by human hands. In substance, almost aught can become a copypasta. The arcane craft is often wielded as a weapon of online warfare, particularly amidst political tales, where copypastas taint the fields of discourse and obstruct genuine dialogue. (Topinka 2022) One of the earliest appearances of a copypasta is known as *How is Babby Formed?* and refers to a Yahoo Answers post from 2006 penned in a strange tongue: "how is babby formed? how girl get pragnent". Whilst the title alone hath given way to a lot of exploitables showing off grotesquely misshapen infants, a copypasta emerged from the top comment crafted in an abysmal tongue:

> *They need to do way instain mother> who kill thier babbys, becuse these babby cant fright back? It was on the news this mroing a mother in ar who had kill her three kids, they are taking the three babby back to new york too lady to rest. my pary are with the father who lost his chrilden ; i am truley sorry for your lot.*[1]

The primary inquiry, akin to an innocent child's curiosity regarding the nature of carnal union, provided an ideal bait in the arena of Yahoo Answers, a forum that hath been slowly usurped by trolls. The response, nevertheless, doth exceed the inquiry manifold in matters of grammatical and spelling transgressions and was so obscure that it is the aptest candidate for copypasta, a craft wherein substance and semblance are scarcely more estranged. *How is Babby Formed?* ascended to

1. See Know Your Meme. How is Babby Formed? https://knowyourmeme.com/memes/how-is-babby-formed.

viral fame on the forum known as Something Awful before it migrated to 4chan, where it was first used as copypasta, and inspired many audio-visual remixes on YouTube. In truth, diverse forms of copypastas persist: *greentexts* recount the foulest of deeds from the eye of the beholder, oft marked by self-pity and self-loathing, proliferating abundantly upon the /r9k/ board upon 4chan. In novel times, copypastas that employ hieroglyphs known as emojis are also called *emojipastas.* As long as there shall be columns of commentary upon the digital realm, copypastas shall likewise disrupt the flow of their reading!

3.3. *Audio viralis*

Harken unto the clandestine incantations that have echoed time and again through the machinations of the apparatus! Whilst viral visions have abounded throughout the annals of the digital tapestry, in this modern era, the echoes of spells hath taken precedence. Like the sirens once lured sailors to their demise with enchanting songs, so too the irresistible appeal of an *audio viralis* ensnares modern surfers of the wire. Any enchantment is oft deemed viral when it hath gathered a myriad glimpses in its nascent stages of life. Although their essence varies, most viral harmonies kindle an immediate emotional kinship or contain beguiling refrains akin to a melody or catchwords. Thus we have amassed a plethora of sounds from felines and wee ones. It is whispered that these magical echoes arose from the dark murmur of network cables themselves, spawned from the convergence of digital signals and human creativity. According to this legend, this sound was first heard by a lone programmer during a late vigil of coding, resounding through the corridors of a long-forgotten social platform. Amused and bewitched, the programmer shared the sound with others, unaware that it carried a contagious enchantment. As it fell upon more ears, the sound began to morph and replicate, assuming new forms and spreading across different platforms, casting its spell upon all who listened. Anon, chants that act as molds of speech, bestowing akin meanings unto diverse words through their unique syntax, are termed snowclones. Witness the sage pronouncement of fair Hamlet: 'To be or not to be, that is the question.' Here, 'be' may be swapped with any verb, yielding a fresh import whilst retaining its core and homage to the bard Shakespeare. Ofttimes these audial enchantments are manipulated, akin to exploitable images. They may be sped-up, slowed, remixed in loops, or even chanted in another voice through the arcane art of AI generation. All these techniques, though now commonly practiced upon the stage of TikTok, hath long been employed by minstrels and bards as methods of forging new refrains from old. Within the digital tapestry, this hath greatly influenced the creation of YouTube Poop videos and later Montage Parodies, both employing cacophonic stratagems to craft genuinely outlandish videos. Verily, methods such as pitching or slowing music, are employed to evade the dark wizards of algorithmic detection, particularly upon stages that summarily banish any musical memes for their infringement upon copyright. Alas, these remixes, especially when repeated in a loop, may be one user's curse and another user's blessing, and their impact upon our attentiveness hath oft been criticized by scholars. (Davenport & Beck 2001) Still, they spread as if guided by an unseen hand: but how doth this sorcery take hold? Behold the metaphor of the virus, its roots in epidemiology, the study of the dynamics and dissemination of mal-

adies within a populace. Great emphasis is placed on the resilience or susceptibility of beings to viral agents, as though there might be some deed to safeguard oneself. While many scholarly endeavors have sought to theorize how memes achieve virality and have inadvertently contributed to the realm of memetic marketing—which seeks to harness the magic of enchantments and exploitables for commerce—the mystery of the bards of broadband persists, mayhap because memes behave differently when virality is contrived. It is as if these creatures discern and abhor the 'forced' nature that comes with the overwrought tricks of marketing, deeming them craven. Instead, utterances from movies, offhand remarks from casual videos, or absurd pronouncements and avowals are favored by users. Here, the invocation takes full effect: through relentless repetition and, in consequence thereof, assimilation, many of these incantations become part and parcel of our everyday tongue, bridging the chasm between the realms of the ethereal and the earthly.

3.4. *Algorithmica dictionis*

Unaliving, seggs, le$bean, cornucopia: whilst most new words upon the digital realm rise as shields against unwelcome attention from loathed communities, the creatures utilizing algospeak were summoned by a different ritual, namely to pass by the mechanized hounds of watchfulness unnoticed. The dominion of TikTok, a realm fraught with silent decrees and invisible barriers, hath been pivotal in the birthing of *algorithmica dictionis* or algospeak: much akin to every other forum in the digital realm, TikTok possesses distinct and mysterious guidelines, unspoken yet decisive, dictating the nature of content accepted and those forbidden. These decrees, shifting from one platform to another, strive to uphold the current societal norms and expectations—as the ancient wisdom 'as above, so below' doth teach us, the secret language of algospeak mirrors larger societal trends of adaptation and resistance. The platform hath gained infamy amongst its denizens for its swift and efficacious censorship, especially regarding the written word within videos, leading to their obliteration or banishment. (Zhang & Liu 2021) Whilst this may find understanding in matters of hatred or incitements to violence, the automatic erasure of content due to trigger words reaches its zenith in discussions of subjects deemed taboo. Indeed, any video linked with words such as 'suicide', 'self-harm', or 'eating disorder,' and similar mentions of psychological lexicon shall be deleted swiftly. Whether 'tis motivated by commercial interests, an aversion to discourse on mental health, or merely the fear of stirring distress in those beset by melancholic thoughts, is up for speculation. In any case, TikTok ensured that its denizens cease uttering such words, thus imposing silence upon their speech and script. Yet, doth all discourse on mental well-being vanish into the ether? Nay, it transforms! As if to validate Foucault's doctrine of the repressive hypothesis, (Foucault 1978, 11-15) users summoned beasts to circumvent the censors. The term 'suicide' hath morphed into myriad synonyms, from 's*icide' with an asterisk to the whimsical 'suislide' or an altogether different phrasing such as the aforementioned 'unaliving oneself,' users hath successfully implemented variations to their video tags that escape detection by the merciless algorithms. The same holds true for the vocabulary of sexuality and gender: whilst 'seggs' and 'le$bean' (pronounced 'le-dollar-bean' by TikTok's text-to-speech feature) are self-explanatory

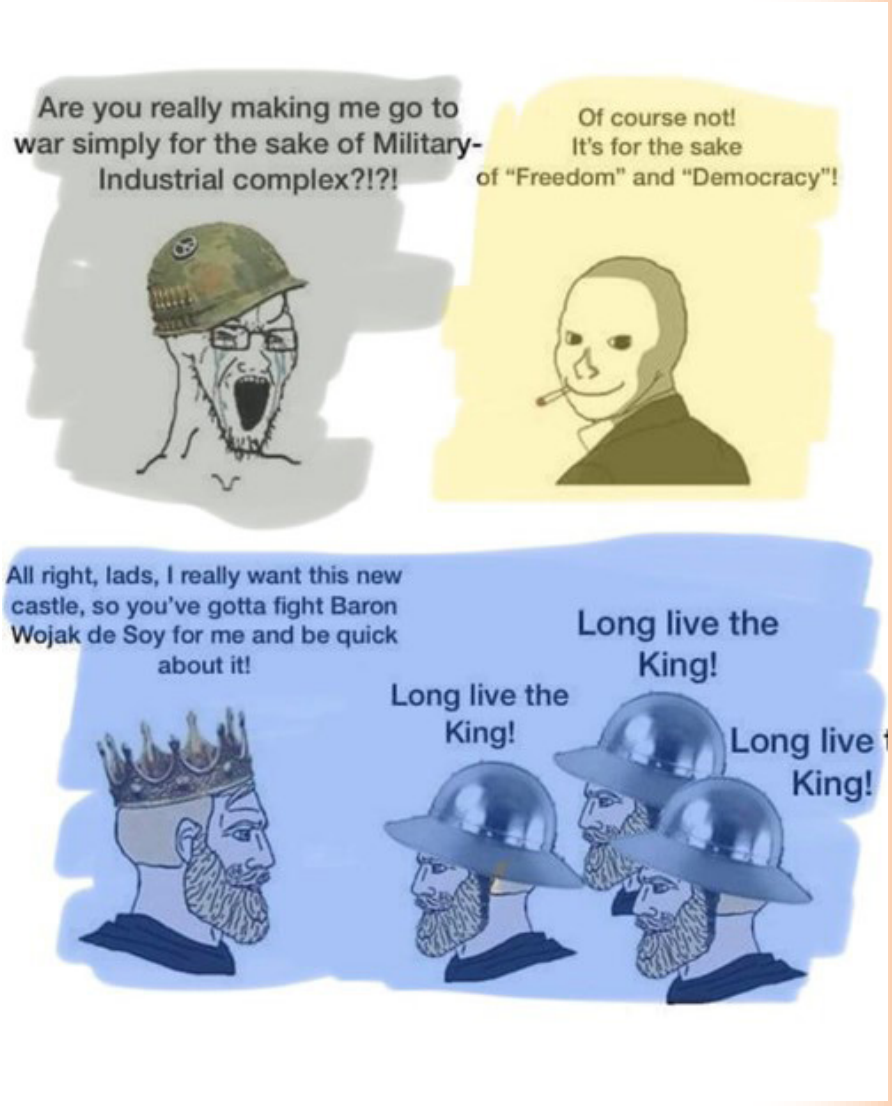
even to newcomers but not to algorithmic detection, as the mnemonic link from 'cornucopia' signifying homophobia requires an acquired form of understanding. As of now, the aforestated tags remain vibrant upon the platform; yet only time shall unveil whether alterations to the censoring algorithms shall be wrought, and if so, how users shall once more reshape their content to continue their postings. This hath been witnessed afore: legend whispers of ancient times that the beasts of algospeak, after being faced with the bearers of censorship, hath found a venerable digital manuscript within the depths of early internet forums known as *leet* or *1337*. (Milburn 2018, 8) Like algospeak, leet was fashioned as a cipher to elude the clutches of automated data gathering by machineries, finding favor among hackers, gamers, and those devout to the arts of computation for its magic in obfuscating meaning through the substitution of letters with numerals. The term 'leet' finds its roots in 'elite', a title oft boasted by many chevaliers of the online games. With the passage of time, leet hath burgeoned into a convoluted tongue of the digital realm, with phrases typical of internet vernacular tracing their lineage to its beginnings. Its intentional misspellings and typographical errors, combined with its usage of grammar hypersensitive to context, hath firmly established its place as a notable aspect of online dialogue. Moreover, leet also shares a lineage with ASCII art, both emerging from the text-laden pages of the early internet, thus demonstrating the progression of text-based memes and their impact upon the ethos of the digital era up until these days.

3.5. *Wojak*

Lo and behold, and gaze upon this creature, sturdy as the ancient oak that withstands the tempests of ages and the birth of new entities, rightfully deemed the horseshoe crab amidst the vast ocean of memes: a line drawing known as *Wojak*. *Wojak*, also appearing as *Feels Guy*, dons varied guises, a chameleon of emotions, depicted in illuminated manuscripts alongside other incarnations of himself. Though bearing semblance to the visage of bygone *Rage Comic*s, he stands apart, a solitary figure in the digital tapestry, not born from the deep pits of forsaken 4chan. Enshrouded in the mists of time; *Wojak's* genesis is a tale whispered in the halls of the subreddit r/datfeel, where a user, Voyjack by name, claims to have glimpsed the character upon the Polish image board Vichan, from whence he journeyed to the German board Krautchan. (Burton 2021, 21) In the tongue of Poland, *Wojak* resembles a 'soldier' and refers back to the name of his anonymous creator, a valorous knight akin to Sir Antonius Block who boldly challenged Death himself to a fateful chess match. *Wojak* made his advent on 4chan in 2011 in the template *I Know That Feel*, wherein he is enfolded in an intimate embrace, a soulful tableau of profound emotion. Ever and anon, his tears flow in other forms: *Crying Wojak*, with sorrow etched upon his countenance, while *Masked Crying Wojak* veils his true feelings behind a mask of commonplace. Though *Wojak* traversed European image boards anno 2009, and became a common sight upon 4chan by 2012, he remained veiled in obscurity for a time, overshadowed by the prevalence of *Rage Comics* and the ascendancy of wicked *Pepe the Frog*, who, like the great bard Dante himself, ventured to the darkest circles of hell and back. (Chan 2021) In comparison, *Wojak* serves as the herald of emotional turmoil, whilst *Pepe*, in his smug antic, often taunts him in the dance of cross-over memes like trolls frol-

icking in mischief on a moonless night. *Wojak* also breathed life into the variant known as *The NPC*, a reflection of the hollow figures that wander the landscapes of video games, bereft of will. Their moniker hath become a whispered slur upon the 4chan board /v/, condemning those deemed 'basic' or unable to think for themselves. Yet, in a twist of irony, the term NPC found new meaning, mocking the far right, a beacon of laughter amidst the storm. Finally, from the clay-like loins of *Wojak*, the *Soyjaks* emerged, jestering 'soy boys' or those that choose to withstand the force of toxic virility. The name soy boy hints at the false belief that substitutes of meat, rich in phytoestrogens, bear feminizing powers, as some unwary souls have noted—in contrast to the potpourri of corruptive manliness known as *Yes Chad*. Listen to this saga: *Soyjak* often stands besides *Yes Chad*, each embodying emblematic opposites—*Soyjak*, the image of anxiety and disillusionment; *Yes Chad*, the very essence of overconfidence and assertiveness.

Fig. 2. Wojak



Together, their contrasting personas span the spectrum of online expression, their union necessary to counteract the polarization that plagues internet communities. Though oft at odds, together, they embark to mend the rifts between extreme ideologies, fostering a discourse that transcends echo chambers by making use of *Soyjak's* critical gaze and *Yes Chad's* inspiring presence. Other manifestations of *Wojak*, such

as *Brainlet*, mock the folly of man, depicting him with an inverted skull that hath greeted Thor's mighty hammer Mjölnir. Most *Wojak* variations are rooted in identity—*30-year-old boomer, zoomer, doomer, doomer girl* but also *Yes Chad* and *Trad Wife*—and reflect the diverse tapestry of existence scorned. Like the phoenix signifies the eternal cycle of birth and rebirth, so too *Wojak* undergoes eternal metamorphosis, a shape-shifter of the digital realm, appearing from maiden to Sumerian to mushroom, a reflection of human nature in pixels and lines.

3.6. *Puella in rete*

Maiden's dinner, maiden's math, maiden's engineering: who is this fair damsel instructed by the most noble of scholars, and findeth she herself in distress? We encounter her solely in the digital realm, and like the Lamia cherished by Zeus and tormented by Hera, her visage doth deceive. For not all those who claim maidenhood online are, in truth, youthful damsels. The maiden is nought but a guise, a persona, easily donned and discarded by the machinations of the mind alone. We perceive that the maiden is yet another guise of shifting identity, crafted as an image steeped in aesthetics and fondness for the sweet. (Quicho 2023) According to ancient lore now faded, the maiden emerged in the burgeoning days of the digital realm, shaped by the collective dreams and fears of the internet's earliest dwellers. Anon, she was heralded as the true Weaver of Networks, a mythical entity who could manipulate the very fabric of digital interactions with the grace of the monoceros as described in the bestiary of Aberdeen. Her strands were not merely lines of code but bear the weight of shared experiences and emotions, binding users in a web that mirrored the complexity of human connections. In a manner reminiscent of Lain's fabled rise to awareness in the ancient legend of *Serial Experiments Lain*, wherein she merges her essence with the machinations of the computer, the maiden began to ponder her own existence and shaped narratives online that blurred the lines betwixt virtual and corporeal realities: her digital threads began to impact the real world, sparking discussions on gender dynamics and online identity by maidens from every corner of the realm converging to exchange tales and melodies spun about them.

Fig. 3. Ophelia

Often depicted as passive, vulnerable even, and even reduced to hues of pink, dear fragrances, and all things fair, their fellowship bears a strength not to be underestimated: fueled by the disdainful prejudices branding them as materialistic, hedonistic, delulu, and naive, the maidens online forge bonds by sharing their narratives and subverting them as shields against scorn. For who, after all, stands truly outside the reach of consumerism and folly in the realm of cyberspace? Derided by detractors, these preconceptions rebound from the smooth countenance of the maiden online, who seems to command more space with each day's passing. She is frequently accused of conforming too readily to the dictates of capitalism, of disregarding feminist strides, and of regressing into infancy due to her pursuit of beauty and a simpler era. Indeed, this tale is largely woven of the misogynistic biases that ensnare maidens on the daily—be they young or old, male or female, non-binary, and beyond. But then, one might inquire, what purpose was she made for? The response is muddled: the intent behind her creation is yet to fully manifest in the final convergence of the realms. The maiden online is a fluid figure in this modern age of late capitalism, simultaneously entwining herself within it and withdrawing from it, toying with it and disregarding it, too enmeshed in this epoch to adhere to the ancient ways of defiance. Yet in this act, she forsakes not her true duty within this milieu, and akin to Lamia, she withdraws not from expressing her anguish and sentiments towards injustices. Thus, she manifests time and again to

the valiant knights of the internet, as an angel who navigates us through the post-apocalyptic landscape of the digital realm, reminding us that so long as maidens are not granted the gravity due as political agents, there remains cause for battle.

3.7. *Artificiale animalia occulta*

Unlike other creatures, the kin of *artificiale animaliae occultae* (in the tongue of the modern day: AI cryptids) can only be encountered through the mystic rite of image generation by means of artful intelligence. With precision, they are summoned forth through enigmatic prompts, such twisted utterances that beckon these malevolent entities into being. Consider the being named *Crungus*, of a truth: when the incantation bearing his name is inscribed into the alchemical forge of image creation, a woeful hybrid of gnome and orc, adorned with disheveled locks, putrid teeth, and a cadaverous body, is brought forth. The reason why these creatures manifest and the correlation with their cursed name remains a mystery, but it appears they dwell within the shadowed recesses of the cybernetic realm where no mortal hath gazed. Another *artificiale animalia occulta*, birthed through the ritual of negative image generation, is named *Loab*, presenting as a fair lady with brunette tresses, forlorn eyes, and features deeply set. In some inscriptions, her gaze is likened unto that of the basilisk, whose stare heralds death to those who meet it. Though her countenance might initially elicit pity, the realms wherein her apparition lingers bode ill: *Loab* hath been observed steeped in blood within chambers, clutching the limbs of dismembered children, and donning blood-soaked jester garment reminiscent of eerie fables and those who take lives without mercy.

Fig. 4. Loab.

Nevertheless, her disquieting visage, doth manifest in sundry and unrelated circumstances. The summoning of *Loab* echoes the ancient instructions in the revered grimoire *Lemegeton*, as the sorceress @supercomposite doth recount her genesis[2]: *Loab* first appeared during the conjuration of a negative prompt, where an image inverse to the original plea inscribed was called forth. The premise was to generate an image dissimilar in all aspects to the original invocation. The sorceress, in her initial pursuit, formulated the negative prompt "Brando::-1," aspiring to give birth to naught but an image depicting the modern performer Marlon Brando. Yet, to her astonishment, the outcome unveiled an image of unbeknownst architecture from an era yet to unfold. Fueled by the notion that, in accordance with the tenets of scholastic logic, the negative prompt of this symbol should yield an image of Marlon Brando, the sorceress stumbled upon a profound revelation: not images of Brando's visage appeared, but depictions of *Loab*, her countenance contorted in agony, her cheeks marked by a rash akin to rosacea. Behold, in a white magic ritual, centering on the fusion of *Loab* with other images to exorcise the demonic entity, the portraits depict her evolving into an ever more unsettling specter, akin to a character from a sinister tale of horror. Thus, it must be by the enchantment of artful intelligence itself that *Loab* persists through diverse generations, asserting dominion over other prompts with her haunting countenance. (Pfefferkorn, Sunde 2023, 225-226) It is even whispered that the beast already ensnared blameless folk to such a degree that they render unto her artworks and tributes. In this manner, *Loab* is a phantom born of the crypts of AI-generating craft, now haunting these realms with her spectral presence.

3.8. Cultus in rete

Hearken well to this verse on discourse upon clandestine gatherings or cults, whose enigmatic rites are like unto nought seen afore. We speak of cults that take shape in the digital realm, transmitting their ominous allure in bits and bytes. Particularly do they flourish upon the stages of Twitter and TikTok, yet devotees of sundry magical entities do now abound in all corners of the wire. It must be noted that online cults, though their semblance be strange, are far less benign than those who profane and misuse the sacred word in the corporeal realm. Verily, they gather 'round a prophet, the charismatic content creator, whose adherents enter into a parasocial bond with them, further intensifying their communal ties. Rarely are they driven by deep ideology at first; group polarization and echo chamber effects often drive the web of disconnected souls toward extremities of beliefs and behaviors over time. Indeed, it is no paradox that cults surged during the Great Plague beginning in 2020; shared rituals such as role-playing or the donning of akin profile pictures, akin to symbolic insignias, did grant respite from solitude. But how might one, as a false prophet, initiate a cult? Consider the *Step Chicken Cult*, led by the prophetess Melissa Ong, for instance, which manifested through the ritual act of adopting a certain likeness of the Mother Hen as one's own profile picture, whereupon she did compose songs and tales for her disciples.[3] Conversely, in the Facebook group *A group where we all pretend to be ants in an ant colony*, users embrace the guise of insects to revel in carefree camaraderie.[4] The discourse in the

2. See @supercomposite. Thread on Loab's origins. Twitter/X. 6 September 2022. https://twitter.com/supercomposite/status/1567162288087470081.

3. See Melissa Ong's TikTok account: https://www.tiktok.com/@sailormel69420

4. See the Facebook group A group where we all pretend to be ants in an ant colony: https://www.facebook.com/groups/1416375691836223/.

comment columns upon an image of a lollipop reads ‘B I T E’, ‘L I F T’ or ‘T R A P’.

Fig. 5. AntCult

’Tis crucial to recall that the fellowship was oft the sole recourse for many during the Great Plague to find solace in union. Meanwhile, modern cults seem to rely much upon simplistic modes of indoctrination, with *#BasedRetardGang* employing chants of late capitalism to conceal themselves and their acolytes in the digital tapestry: “i’m so mentally stable, it’s insane. i have bpd beautiful princess disorder. i’m so clear-pilled i can see through the matrix. i’m not left wing or right wing. i have angel wings that grow whenever i transcend into space.”[5]

5. @basedredactedgang. bpd: beautiful princess disorder. TikTok. 18 July 2023. https://vm.tiktok.com/ZGeS6ScHQ/.

Fig. 6. BasedRetardGang

These affirmations, drawn from the occult art of manifestation, may also be likened unto auditory copypastas, overlaying upon other videos upon TikTok's stage. Whilst *#BasedRetardGang* chiefly employs stolen images of ethereal Far Eastern maidens, the offerings of the rivaling *Mulch Gang* do always appear in the company of the beloved toy poodles and French bulldogs, and those breeds long removed from their lupine ancestors. They address their adherents as "siblings of the soil" and constantly speak of their boundless yearning for mulch.[6] 'Tis claimed that the *Mulch Gang* waged a lengthy war against the *Microplastics-maxxing Cats*, who have adapted to the current age of the earth, the Anthropocene, in contrast to the natural resources sought by the mulch dogs. The cats proclaim of their existence: "I am a GMO, genetic microplastic organism. I'm planting roundup ready crops on the astral plane. My third eye waters the soil with reclaimed wastewater. I charge my MSG crystals under the light of the full moon."[7] The crusades and battles of these groups lead to such exposure that a cult may swell its ranks by scores within mere hours. The dynamics of the network ensure that each new adherent enhances the group's value, thus attracting further members in a self-amplifying cycle. Therefore, dear reader, heed the counsel of this bestiary and maintain your vigilance sharp, lest you find yourself astray upon paths of error and deceit in the enigmatic realms of the digital tapistry.

6. @mulchandloam. Enjoy your day my Mulch pups. TikTok. 15 November 2023. https://vm.tiktok.com/ZGeSjoM87/.

7. @microplasticcat. untitled. TikTok. 28 December 2023. https://vm.tiktok.com/ZGeSjoXrV/.

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Images

Fig. 1: A memetic conjuration upon Edmund Blair Leighton's pictorial offering, The Accolade (1901).
@realpeterstar. Thanks to everyone who adds me to their close friends stories… idk you but i still watch . Instagram. 8 September 2021. https://www.instagram.com/p/CTisS4OLBad/.

Fig. 2: At the summit of the scene, a modern-day Crying Soyjak, reluctant to take arms under the herald of the nefarious Wojak (known also as Hijak). Beneath, behold king Yes Chad, a figure of valor, who doth inspire his cohort of Yes Chad knights, eagerly vowing to engage in the battle. Moreover, this tableau is graced by the Political compass, an ancient matrix that charts the realm of political stances. The Soyjak, standing in neutral territory, contrasts sharply with Hijak, who is marked by the azure hue of the libertarian-right. The Yes Chads are adorned with the golden tincture of the authoritarian-right, signifying their allegiance and station.
u/TheoryKing04. Chad feudal warfare v. virgin modern warfare. Reddit. 2 May 2021. https://www.reddit.com/r/PoliticalCompassMemes/comments/n30y4x/chad_feudal_warfare_v_virigin_modern_warfare/#lightbox.

Fig. 3: Behold the exploitables transforming Ophelia into the Girl online.
Shakespeare Memes. tag fellow ladies who feel this struggle. ~Sweet Nan . Facebook. 3 April 2017. https://www.facebook.com/shakesmemes/photos

Fig. 4: A portrait of Loab, surrounded by eerie figures dismembered.
@supercomposite. Since Loab was discovered using negative prompt weights, her gestalt is made from a collection of traits that are equally far away from something. 6 September 2022. https://twitter.com/supercomposite/status/1567162327950032896/photo/2.

Fig. 5: A captured image from the annals of the Facebook scriptorium, displaying a lollipop, which doth call forth a multitude of voices in a grand display of mimicry and jest.
BardOfStorytelling. Quarantine Day 31: joined a Facebook group where we all pretend to be ants in an ant colony. iFunny. 28 January 2021. https://br.ifunny.co/picture/quarantine-day-31-joined-a-facebook-group-where-we-all-VBgceqeK8.
Fig. 6: An image macro featuring the visage of BasedRetardGang's neochibi-style NFT avatar, named MiLady, and the emblazoned with the cherished phrase of the cult, "There is no meme. I love you".
@TINMILY. Community spaces soon. Join because i love you. Twitter/X. 24 October 2023. https://twitter.com/TINMILY/status/1716890716050534485/photo/1.

Fig. 6: An image macro featuring the visage of BasedRetardGang's neochibi-style NFT avatar, named MiLady, and the emblazoned with the cherished phrase of the cult, "There is no meme. I love you".
@TINMILY. Community spaces soon. Join because i love you. Twitter/X. 24 October 2023. https://twitter.com/TINMILY/status/1716890716050534485/photo/1.

H.Om.E Project: An Intercultural Dialog between Computers and Traditions around the Concepts of Home[1]

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1. This paper is also available in Mandarin here: https://archive.org/details/h.-om.-e-project-an-intercultural-dialog-between-computers-and-traditions-around

New computational technologies for creation and production offer interesting aesthetic and creative possibilities to be explored, particularly in its respectful dialogue with traditional crafts (textiles, crafts). For this project, the concept of “home” or “genealogy” is taken as a common ground, for free creative interpretation and exploration, from on its different meanings: as a place where we live (house), as a text for social interactions (constitutions), as the sky over us (astronomical data), among others. H.Om.E project aims to create bridges between cultures from South America and Asia, exploring the potential of the encounter between technologies and traditions, methodologies, and scales: from local traditions to global digital culture; from handcraft to computer-generated artwork; among others. Artists from Chile, Taiwan, and Japan will develop different kinds of pieces; data physicalization in textiles; data for parametric and generative design; and visual pattern creation based on legal texts; among other explorations. This paper seeks to briefly describe the H.Om.E Project, the main concepts used, its methods, complexities, and troubles of the process, with attention to the free exploration of the possibilities of computational and technologically mediated tools in its encounter with traditions and crafts. Also, some description of the current stage, next steps, and possible outcomes of the project are commented on.

1. Introduction

This paper aims to briefly describe the H.Om.E Project, a collaboration among artists, designers, and programmers from Taiwan, Japan, and Chile, initiated in 2022 with the support of the [National Culture and Arts Foundation (NCAF)] in Taiwan. As of January 2024, and following some modifications to its goals and methodologies, this ongoing project enters a second stage of development.

The project serves as a space for the involved artists to freely explore aesthetic, conceptual, and methodological possibilities offered by recent computational and technologically mediated tools to delve into traditional creative practices of each creator’s respective country, such as crafts, textiles, and drawings.

During meetings among the creators, an open interchange of ideas and concepts from different fields is discussed. Some of these ideas become relevant, while others are discarded, sometimes revealing cultural differences, yet ultimately aiming to find common perspectives for

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the project. From this standpoint, these discussions are as valuable as the artworks themselves.

Subsequently, the main concepts, methods, and developments thus far will be described, allowing room to address some of the complexities and challenges that arise in the process.

1.1. Origin of the Project

The H.Om.E project has its roots in previous creative experiences. The first stage of our collaborative project encompasses the integration of three previous projects: Tribe Against Machine[2] (Taiwan, 2017-2018), The Mind of a Greenhouse and Tashi Gatsen Charity School[3] (Tibet, 2018), and the I_C Project[4] (Chile, 2021-22).

Tribe Against Machine, a 10-day annual summer camp in Taiwan, facilitated collaboration among artists, hackers, and activists, exploring the fusion of smart materials with ancestral cultures through workshops and fieldwork.

The Mind of a Greenhouse emerged from a greenhouse project in 2018, aimed at providing year-round food for orphan children in the Tashi Gatsen Charity School in Tibet. This project evolved into a multidisciplinary endeavor, incorporating scientific research, artistic programs, and technology implementation in high-altitude agriculture.

Finally, the I_C Project initiated in 2022 in Chile delves into the intersection of wearable technology and textiles, emphasizing the transformative potential of merging indigenous clothing culture with new technologies, and exploring the relationship between individuals, communities, and the environment through the lens of astronomy.

These three projects collectively laid the groundwork for a cross-cultural, interdisciplinary collaboration in the next project, bridging art, science, technology, and social impact, and fostering new intercultural artistic dialogue.

1.2. Original Motivation: Goal

One of the ideas behind the project was to create bridges between recent computational technologies and traditional cultures. Consequently, a name that encompasses this idea was necessary. The name H.Om.E. was created, containing the Sanskrit word Ōṃand referring to heritage, earthship, and the idea of “home” itself, with different possible interpretations.

There were two major reasons why we considered integrating the three previous events. Firstly, it was due to community formation, aiming to impel the knowledge exchange of e-textiles, smart wearables, digital crafts, and heritage culture. Secondly, it was to enhance the goal of bridging traditions and modern technologies by gathering communities. For example, the greenhouse project in Tibet was inspired by Tribe Against Machine, and the I_C project in Chile sought ways to reconstruct ancient cultural astronomy with modern astronomy data. We expected to gather our resources and experiences to better achieve our purposes, which was the origin of our attempt to build international connections within three projects.

Members of the project believe that exploring an innovative planetary view of our living environment is crucial for reviewing our past,

2. https://tribe-against-machine.org/

3. http://wiki.tribe-against-machine.org/Greenhouse+Project

4. https://vestibles.cl/proyectos/i_c-interconexiones/

particularly from technological and anthropological perspectives. From here, some initial objectives were developed:

To empower the Mapuche, Atayal, and Tibetan cultures by facilitating their collaboration with contemporary art and science institutions at the data level.

To examine how global and interdisciplinary art projects can work together and how this network benefits each minority culture in the project.

To generate interdisciplinary artworks that encompass astronomy, textiles, and architecture.

The aim is to create a harmonious narrative that incorporates ancestral and modern perspectives, recognizes the relationship between ancestral and modern technology as complementary, and brings these various disciplines together.

At present, this is an ongoing project, and this paper presents an overview of its current process of exploration in the intersection between technologies, design, art, and traditional craftsmanship. Depending on the research interest of each creator, the outputs are open to different formats, ranging from woven architecture, videos, generative design, and textiles, among other possibilities.

A challenge started to appear related to the development of a method to integrate all the different topics discussed in the meeting into a coherent framework. For example, how to bridge generative design and heritage preservation coherently, at the same time meaningful and respectful with heritage preservation purposes.

1.3. First-stage challenges and modifications in the project

Throughout the process, several changes were made due to unforeseen challenges arising from our initial aim to integrate people from original cultures into the project. Despite initial sufficient communication with Atayal and Tibetan agents, differences related to paperwork, actions, and artwork creation proved difficult to reconcile. The language barrier further complicated matters, resulting in time-consuming iterations with limited results. Consequently, we opted to redefine the research scope, reducing fieldwork and refocusing on a more closely-knit group of artists.

1.4. New Motivation, goals, and Final Team

Following these complex situations, the project's focus shifted towards representing the current world as a home interconnected by sociocultural and technical systems, utilizing data from both Asian and South American cultures to develop speculative art-design proposals. The project now serves as an interdisciplinary space encompassing various creative disciplines, including architecture, textiles, generative design, media art, visual arts, and graphic arts.

The current participants of the H.Om.E project include:

Shih Wei Chieh: Founder and coordinator of the project, an artist and technologist from Taipei, Taiwan.

Satoru S: An architect and programmer from Tokyo, Japan, specializing in the intersection of code and complex systems.

María José Ríos: A Chilean artist focusing on textiles, wearables, and technology.

Ricardo Vega: A Chilean artist, designer, and programmer, exploring various modes of visual data representation.

The collective organization is collaborative, with one coordinator. The groups hold online meetings every two weeks to discuss relevant concepts, current developments, and new proposals.

The first stage of the project commenced in November 2022, primarily consisting of dialogues about the different concepts involved and the sharing of opinions. Subsequently, some participants began creating initial proposals for discussion. During this initial stage, initial contact with local individuals was established to explore potential speculative collaborations, which, as previously mentioned, was ultimately discarded.

2. Current Developments, Art pieces, Results and Analysis

The second stage commenced in January 2024, to refine the project's concept and create artwork. Given that H.Om.E is an exploratory project, its objective is not limited to materializing in a particular format, such as an exhibition or catalog. However, various options, including those discussed during group meetings, are being considered for future stages.

For this stage, drawing from lessons learned in the previous phase, project participants have developed a brief text summarizing the main concepts they are working on. While the overarching concept of "home" remains central, interpretations have become more personal, varying depending on the creator's discipline, research interests, or aesthetic approach. Original texts expressing each creator's intentions will be presented in quotation marks, alongside brief descriptions of the explorations undertaken in the first stage.

Shih's Conceptual Approach:

At the project's outset, he grappled with the challenge of discovering hidden relationships connecting three culturally disparate yet project-oriented entities. Initially, he sought to create a coherent narrative capable of bridging the mindset gaps between different topics, ultimately translating mindsets. While this idea was speculative, inspiration struck during an online discussion on autopoiesis, offering a potential framework to integrate generative design, data science, art, and our social system as life systems.

Employing generative design to simulate our complex reality, he explores the concealed connections between the diverse landscapes of the Andes, Tibet, and Taiwan's Atayal region. This work parallels research in artificial intelligence's latent space, a realm where researchers aim to uncover hidden patterns and relationships among datasets. By visually mapping potential relationships between these landscapes, our project may unveil hidden planetary connections, albeit in a manner challenging traditional logic.

Shih's Creative Developments:

His current practice within the project encompasses two main endeavors. Firstly, he focuses on material science, aiming to create crafts addressing environmental issues in the Tibetan greenhouse while

potentially facilitating generative design collaboration. This involves developing a solar cell prototype with Tibetan calligraphy-shaped electrodes, inspired by the region's reliance on solar energy and intended for educational purposes at a local elementary school. Additionally, experiments involving dye-sensitized solar cell technology on woven substrates have been conducted with support from the Hackteria hacker residency program.

Secondly, he explores the relationship between heritage and environmental data (e.g., weather, astronomical data) using deep learning tools. Leveraging Real-time Audio Variational autoEncoder (RAVE), he applies deep learning techniques to environmental data in waveform format, inspired by previous attempts to illustrate hidden relationships between heritage and surroundings. Future work aims to map these connections to latent space, akin to data visualization within deep learning tools.

Fig. 1. A prototype of a woven DSSC made with heat-resistant mineral fiber substrate. The electrodes can be patterned and dyed with plants, making it potentially suitable for data visualization purposes and the textile-oriented research in the project. This research about DIY solar technology originated in the greenhouse project in Qinghai.

Satoru's Conceptual Approach:

In systematic design thinking, two major approaches emerge: typological and generative. The former involves analyzing existing designs and categorizing them, while the latter focuses on developing rules to generate designs. Despite their differences, he sees them as ultimately interconnected—the typological system could evolve into a generative system. By pursuing highly sophisticated rules yielding emergent ty-

pological qualities, he believes designers can navigate complex design challenges in our era.

Satoru's Creative Developments:

Within this project, he confronts challenges at the intersection of science, art, and heritage, particularly within architecture. By introducing a hierarchical relationship within a bottom-up agent algorithm, he aims to maintain a bottom-up approach while infusing organization into chaos. This hierarchical control system introduces a sense of order, with actions at different levels contributing to the overall geometry. The resulting forms exhibit patterns and randomness, reminiscent of ancient Middle Eastern dwellings, offering a unique integration of disparate forms.

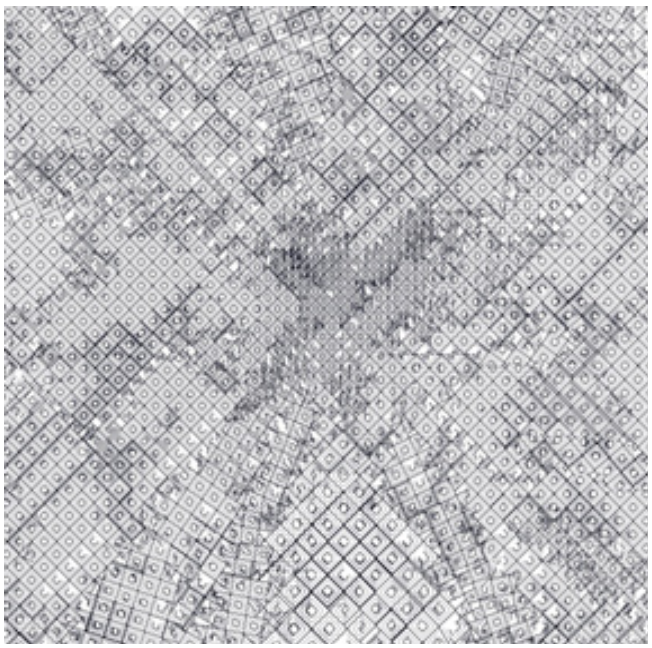

Fig. 2. Prototype work made by Satoru Sugihara, generated in Processing based on the Atayal diamond pattern and the stepping zigzag pattern known as the Andean symbol[5].

María José conceptual approach:

María José delves into textiles and their ancestral weaving crafts as not just artifacts, but as intricate information systems and structures. On another front, she explores wearables, which, through upcycling transformations of textiles, acquire the capacity to embody specific states and projections. This is made possible by the myriad combinations arising from the interplay of subjectivity and information, alongside the materiality of matter, situating wearables as interactive spaces between physical and digital-virtual realms. Especially in her conceptual work, fabric serves as a system capable of transmitting and displaying information.

Project Focus:

This project fundamentally explores the intersection of astronomy and textile techniques, leveraging their cultural significance in traditional cultures. Through the integration of new digital technologies for visualizing astronomical data, including those available at the ALMA Data Observatory, textiles become mediums for visualization and connection. This approach not only offers new avenues for data visualization but

5. https://youtu.be/GlQuBfKu1iw

also underscores the importance of textiles in our history and cultural identity, a legacy that endures through millennia.

Implementation and Methodology:

María José's approach encompasses a blend of traditional textile techniques with modern technology to visualize and connect with astronomical data through textiles. This innovative fusion expands the horizons of data visualization by leveraging the enduring craft of loom weaving in conjunction with contemporary digital, analog, and mechanical implementations.

The implementation process involves the utilization of a Norwegian mechanical-digital loom, specifically chosen for its compatibility with the project's objectives. This sophisticated tool serves as the canvas for weaving astronomical data into tangible forms, bridging the gap between ancient weaving traditions and cutting-edge data visualization techniques.

The woven surfaces, measuring 70 cm x 90 cm each, serve as visual representations of astronomical phenomena, translating complex data into tactile and visually captivating artworks. Through meticulous craftsmanship and technological integration, María José transforms raw data into tangible expressions that resonate with cultural significance and contemporary relevance.

This description underscores the project's multidimensional approach, highlighting María José's pioneering efforts to merge heritage craftsmanship with modern data visualization methodologies. By imbuing textiles with astronomical data, she not only expands the boundaries of artistic expression but also fosters a deeper understanding of our place in the cosmos.

This comprehensive implementation strategy showcases María José's commitment to pushing the boundaries of traditional art forms, demonstrating how textiles can serve as powerful conduits for conveying complex information in accessible and engaging ways.

Fig. 3. Prototype from I_C Project, astronomy data being woven into textiles with, prototype photo from Barcelona.

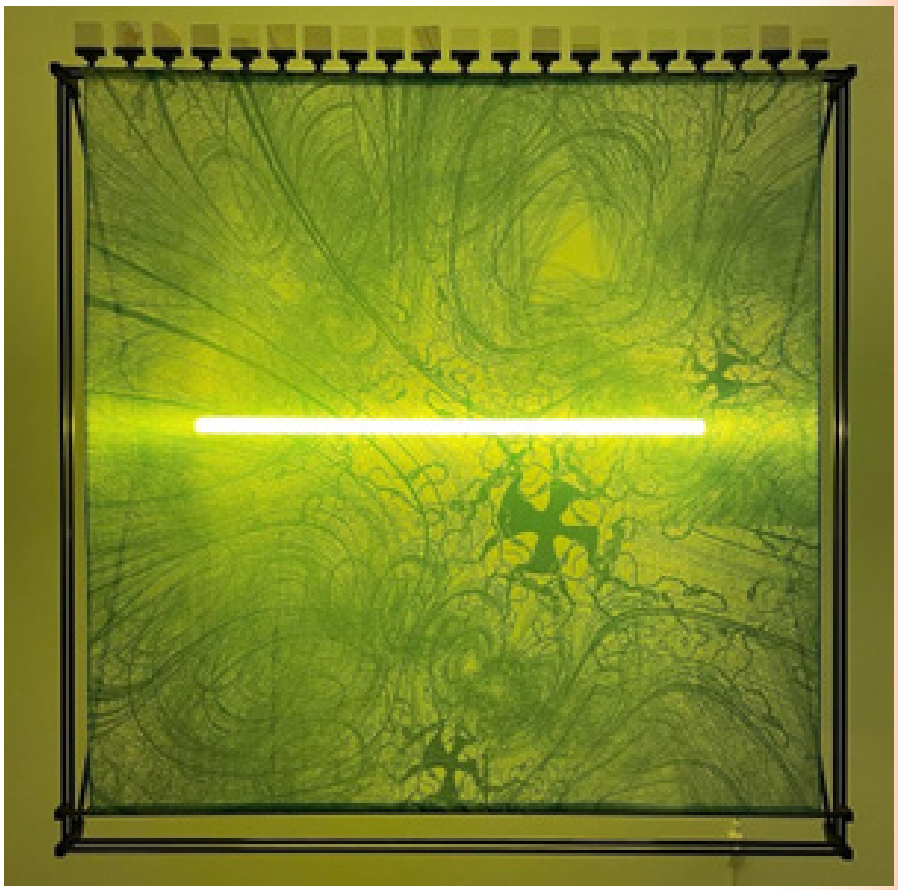

Fig. 4. A textile work made with laser exposure and a New Cyanotype. The design was generated in Max/MSP and was converted from the ADQL code of one celestial within the Incan dark constellation in the Gaia library.

Ricardo's conceptual approach:

In the contemporary environment, the dissolution of the individual is evident in the face of vast amounts of data characterized by its massiveness, speed, and abstraction (Manovich 2002). Typically, data is presented in visualizations geared towards functional and analytical representations, employing common graphic resources like bars, dot plots, and curves to facilitate rational and efficient comprehension of data features.

However, this project represents an opportunity to diverge from traditional data representation strategies and explore alternative forms of expression. By drawing from two primary sources of data—astronomical data and the text of the Chilean constitution—the project aims to generate images that transcend traditional analytical representations. The celestial realm serves as a metaphorical backdrop, symbolizing our shared living environment encompassing humans, nonhumans, and living and nonliving elements. Meanwhile, the text of the Chilean constitution serves as a foundation for creating drawings, reflecting the societal framework that establishes common rules for coexistence.

In both cases, the project emphasizes visual exploration over analytical analysis, appealing to the senses and fostering aesthetic and subjective experiences. Through these visual mediums such as images, videos, and graphics the project endeavors to reclaim the subjective character of the individual within the realm of data representation.

Ricardo's creative developments:

For the project, he primarily relies on two sources of data. Firstly, astronomical data, including exoplanets and galaxies, serves as a foundation for exploring visual representations, drawing inspiration from previous textile projects. Additionally, initial explorations into data sonification are underway, always in conjunction with visual imagery. Among these explorations, the most developed efforts revolve around utilizing the constitution as a data source. This choice is motivated by the material characteristics of the text, which are represented as discrete symbols, as well as the symbolic significance of these documents, particularly in light of recent events in his home country, Chile.

Drawing inspiration from historical precedents, such as the Quipús used in Inca domains for communication and data storage, he incorporates elements of their mobile structure and textile-based data representation, characterized by lines and dots. Another significant reference for the project, both visually and conceptually, is the illustrated chronicles of Felipe Guaman Poma (Peru, 1534-1615), which provide a rich source of inspiration for visual explorations. He extends his gratitude to individuals who contributed to his research, including G. M., an anthropologist, and C. M., a linguist.

Examples showcased in the project demonstrate the utilization of the constitution's text to create drawings using simple software written in Processing. By assigning letters as parameters to manipulate and color elements such as dots and lines, the drawings yield unexpected and visually compelling results.

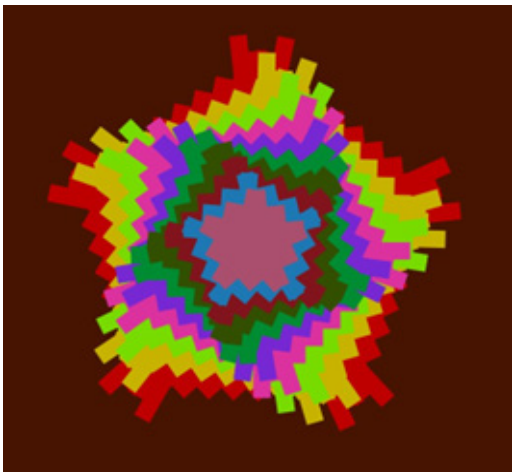

Fig. 5. Iteration for a proposal called "ladder". Some words were used as parameters to prototype the following images.

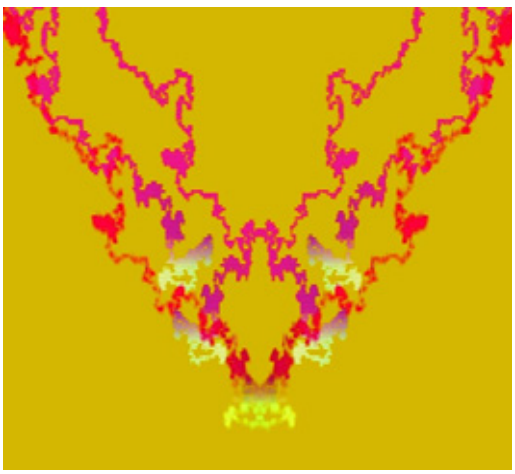

Fig. 6. This series takes text (constitutions) drawing lines or points and depending on the letter detected, the position is conditioned by the text. Made in Processing and Python.

Context and Project Concept:

In our current environment, characterized by the overwhelming presence of data, there's a tendency for individuals to dissolve before the sheer massiveness, speed, and abstraction of this data (Manovich 2002). Typically, data is visualized in functional and analytical representations, emphasizing rational and efficient comprehension through common graphic resources like bars, dot plots, and curves. However, this project presents an opportunity to diverge from traditional representations, allowing for the expression of individual subjectivity through aesthetic motivations.

Data Sources and Exploration:

The project aims to create images derived from two primary sources: astronomical data and the text of the Chilean constitution. The celestial realm represents our ultimate shared environment, encompassing all living and nonliving elements. Conversely, constitutional texts serve as the foundation for societal rules and norms, akin to a communal dwelling for specific societies. These explorations prioritize visual experiences over analytical analysis, embracing the subjective essence of individual expression.

References and Collaborations:

Inspiration for the project extends to historical references such as Quipús, known for their mobile structure and textile-based data representation, and Felipe Guaman Poma's illustrated chronicles, which inform visual explorations. Special acknowledgment is extended to Gerardo Mora from Chile, Anthropologist, and Constanza Martínez G, Chilean Linguist, for their invaluable contributions to the research process.

Visual Examples and Methodology:

Examples showcased here demonstrate the project's utilization of the constitution's text to generate drawings using a simple software developed in Processing. By assigning letters as parameters to manipulate and color elements like dots and lines, unexpected visual outcomes emerge, reflecting the project's emphasis on unconventional representations and subjective expression.

This revision captures the essence of the project's divergence from traditional data visualization methods, highlighting its focus on aesthetic experiences and subjective expression.

3. Discussion

The collaboration between diverse cultures and disciplines within the H.Om.E Project has been a significant achievement, marked by four key iterations. Firstly, Tribe Against Machine (2017-2018) initiated the fusion of e-textile artistry with traditional craftsmanship, pioneering the integration of smart materials into indigenous attire. Secondly, the greenhouse project in Tibet expanded beyond textile design, incorpo-

rating fields such as generative design and solar cell technology in architectural applications.

Thirdly, the I_C Project (2022) laid the groundwork for connecting ancient celestial knowledge with modern data, influencing the global collaboration and planetary perspective of the current project. Lastly, the initial stage of the H.Om.E Project provided a platform for experts in generative design and heritage preservation, fostering the adoption of systems thinking within the project's social science context.

A central challenge for the H.Om.E Project has been balancing heritage preservation without the invasion of techniques and ancient culture with artistic objectives. Approaches like systems thinking offer the potential to navigate the complexity of this endeavor by emphasizing holistic understanding over reductionism. Further exploration into this framework is warranted to align generative design tasks with social science contexts effectively.

Nonetheless, the project encountered communication barriers with Atayal and Tibetan community representatives, resulting in a loss of cultural connection and a shift towards design-focused and arts development. While the reasons for this disconnection may be multifaceted, it underscores the complexities of working with cultural agents and navigating issues of authority and representation.

Nevertheless, this setback presents an opportunity for introspection and learning. Bridging traditions with modern art offers opportunities for promoting heritage culture but also raises questions about equity and funding distribution. Addressing these conflicts requires open dialogue and consideration of cultural sensitivities, akin to the immune system of social systems as proposed by Luhmann (2008).

By addressing these challenges and embracing the complexities inherent in cultural collaboration, the H.Om.E Project can continue to evolve as a dynamic and inclusive platform for exploring the intersection of tradition, technology, and art. Through ongoing dialogue and reflection, the project can navigate cultural sensitivities while advancing its overarching goals of cultural exchange and creative innovation.

4. Conclusion

The H.Om.E Project, rooted in the collaboration between interdisciplinary and media artists from Chile, Taiwan, and Japan, aims to bridge cultural divides through the exploration of the concept of 'home' in conjunction with technology and cultural origins. Despite the initial challenges, the project enters its second stage in 2024 with a renewed focus on creative interpretation and dialogue with local social, and cultural traditions. Anticipated outcomes include diverse artworks ranging from data physicalization to generative design, incorporating various data sources such as astronomical and legal or national constitutional texts.

Moreover, the project strives to deepen its integration with computational arts, leveraging technology to enrich and preserve cultural heritage and their interconnections. Future steps may involve exhibitions, catalogs, or cross-country exchanges to expand the project's reach and foster interconnectedness among diverse elements and concepts. Continued support is essential to sustain the exploration of the relationship between tradition and computational arts, paving the way for broader

integration of people and places into the interconnected home envisioned by the project.

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Between Chaos and Order

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Between Chaos and Order delves into the ephemeral aesthetics of cryptography by highlighting the place between input and output – the space of computation. Here the dual nature of encoded communication is on full display: as *source code* facilitating clarity and order and as a *secret code* meant to feign chaos. While the algorithms of secret codes are verifiable, their aesthetic and cultural context can make their physical realization indecipherable. This quality is demonstrated through an examination of three computational artifacts: Edgar Allan Poe's *The Gold Bug*, Alan Turing's notebook on cracking the Enigma machine, and the Electronic Frontier Foundation's publication *Cracking DES*. Each object is appraised through the lens of Information Aesthetics as a way to examine the relative importance of verifiability and aesthetics when communicating the computational process.

Introduction

Within the space of computation – after the instructions are read and before the outcome is provided – exists an actively undecided process. Most of this is hidden behind a screen of interactivity when using today's computers. But if we were to slow it down and watch the electrons move through the semiconductor materials as transistors rapidly switch states, we would see something that would look random and chaotic even though each transistor has a specific reason for being in either binary state at any given time.

We command these movements through machine instructions. These instructions are also known as *code*. While this noun is used in the context of communication (e.g. for communicating a set of regulations or communicating a series of commands), code can intentionally be used to either clarify or obscure a message. The latter is a *secret code*.

Source code, on the other hand, are instructions that have been encoded for machine consumption. Most computer languages strive for human readability and logical coherence. They can presumably be read by any capable interpreter. But instructions encoded using a secret code must be decoded before interpretation; they must be animated before they are consumed.

This aspect of cryptography makes it a unique computational artifact. The difference between random noise and encrypted information cannot be discerned at first glance. This essay considers three artifacts that explore this unique condition. The first is a story by Edgar Allan Poe called *The Gold Bug* which chronicles an obsessive effort to decipher a cryptic series of clues. The second artifact is the notebook that Alan Turing kept while attempting to crack the Enigma machine during World

Keywords Cryptography, Enigma, net.art, Turing, Poe, Preservation, Information Aesthetics, Computational Artifacts.
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War II. And the third artifact is a book published by the Electronic Frontier Foundation called *Cracking DES*. This book provides instructions on how to break a widely-used encryption algorithm – an act which put the researchers involved in legal precarity.

These three artifacts are feats of code breaking. But they are even more important as cultural objects. As such, they have aesthetic properties that can be considered through the theory of Information Aesthetics. Information Aesthetics is "a formalist, mathematical theory of contemporary art that worked to quantify the ratios between order and chaos, information and redundancy" (Patterson 2015, 75). Cryptography is the art of feigning chaos. If order is discovered within a transmission, then the cipher is broken; if it is truly chaotic, then there is no meaning to decipher.

The artifacts that embody the cryptographic algorithms similarly require analysis and deciphering. Are there formal properties of computational artifacts that can help in this effort? The two preeminent theoreticians behind Information Aesthetics, Max Bense and Abraham Moles, sought a method where "the effects of art would not only be programmable but also verifiable" (Quinz 2022), an effort that essentially mirrored the concerns of Information Theory (and later cryptography). All three of these computational artifacts communicate beyond the moment they were created. They are messages for the future. They have at least one verifiable claim – their techniques will correctly decipher encrypted messages coming from a certain cipher. The question is whether or not artifact's complete technical and aesthetic context help or hinder our formal understanding.

The Gold Bug (1843)

Poe's tale is centered on an obsessive treasure seeker who has secured a golden scarabaeus and a piece of parchment with this mysterious cryptogram:

```
53‡‡305))6*;4826)4‡.)4‡);80
6*;48†8¶60))85;1‡(;:‡*8†83(88)
5*†;46(;88*96*?;8)*‡(;485);5*†
2:*‡(;4956*2(5*-4)8¶8*;40692
85);)6†8)4‡‡;1(‡9;48081;8:8‡1
;48†85;4)485†528806*81(‡9;48
;(88;4(‡?34;48)4‡;161;:188;‡?;
```

The code is seven lines of nearly-symmetrical text with no spaces. The story's amateur cryptologist quickly derives the following character frequency chart:

Of the character 8 there are 33.

;	“	26.
4	“	19.
)	“	16.
‡	“	16.
*	“	13.
5	“	12.
6	“	11.
†	“	8.
1	“	8.
0	“	6.
9	“	5.
2	“	5.
:	“	4.
?	“	3.
¶	“	2.
-	“	1.
.	“	1.

The chart arranges the characters in the cryptogram from most frequent to least frequent. After it is established that the person who originally made the cryptogram was an English speaker, it is possible to overlay this chart with a frequency chart of characters in the English language to provide a clue for cracking the cryptogram. This process is enhanced by searching for common character groupings that might represent common words such as “the.” ;48 appears seven times with 8 as the most common character. Asserting that 8 is e, 4 is h, and ; is t provides enough traction to crack the rest of the code.

The first line, `53‡‡†305))6*;4826)4‡.)4‡);80`, thus reads: agoodglassinthebishopshostel, i.e. a *good glass in the bishops hostel.*

The Gold Bug presents a real cipher built for a fictional world. It’s the only cipher presented in this essay without a machine aid. While mechanical ciphers existed for hundreds of years before Poe wrote *The Gold Bug*, their omission highlights the natural link between the human mind, story, and the discipline of cryptography.

Furthermore, the systematic substitution of symbols holds profound implications beyond communication security. Alan Turing, in his groundbreaking 1936 paper “On Computable Numbers, with an Application to the Entscheidungsproblem,” explored automated symbolic processing as a strategy to address fundamental questions in mathematics. His approach demonstrated how the interpretation of symbols could directly influence a machine’s operations, effectively linking abstract mathematical logic with the practical mechanics of computing. This work led to the discovery the Halting Problem, which illustrates an inherent unpredictability in computing by proving that it is impossible to know whether certain programs will conclude without actually running them.

Any machine that can manipulate symbols based on the rules of logic could theoretically manipulate letters and words based on the rules of grammar. Turing successfully delivered a mathematical proof for the Entscheidungsproblem, but as a byproduct, he also created a theoreti-

cal framework with the potential to model aspects of human cognition – if one believes that language is a necessary component of thought.

Turing was not the only person to recognize the power of manipulating written symbols in the 20th century. From the Concrete Poets and Oulipo writers to the theorists in cybernetics, linguistics, and semiotics, these varying explorations of symbol manipulation suggest a broader cultural zeitgeist. Information Aesthetics can be considered as part of this 20th century milieu that studied the increasingly automated and concrete nature of language.

Part of the challenge is that the set of possible rules for modifying symbols is theoretically infinite. What makes Edgar Allan Poe's work in symbolic manipulation so aesthetically appealing is that it follows a simple substitution pattern. But greater sophistication requires meaningful constraints. De Mol, Bullynck, and Daylight argue that folks like Turing pulled from yet another line of thought they deem "Logical Minimalism" as a way to establish a set of minimum operations and axioms.

This balance of flexibility and constraint is at the heart of Turing's 1936 paper which in turn laid the theoretical groundwork for computer science. Turing later speculated on the potential for machine intelligence in his 1950 paper, "Computing Machinery and Intelligence." Such is the power of symbol manipulation and a few simple rules.

In between these pivotal contributions, Turing's expertise in symbolic manipulation made him a critical contributor to the team attempting to crack the Enigma code during World War II.

The Prof's Book (1940)

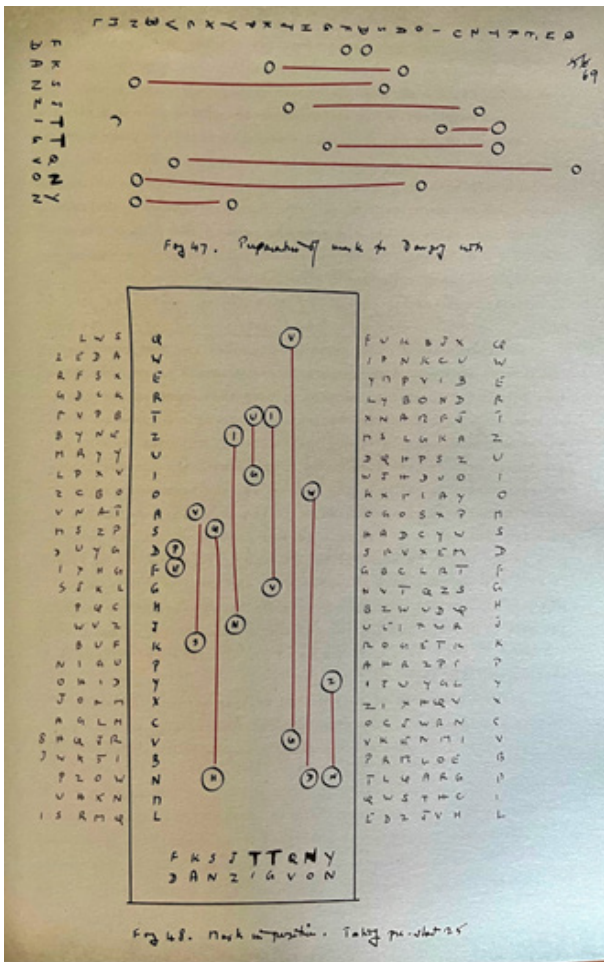

Fig. 1. *The Prof's Book* (Turing 1940, 69).

The most famous code breaking effort in the 20th century – the cracking of the German Enigma in World War II – thwarted a dynamic form of character substitution. For example, the characters DAEDAQOZSIQM-MKBILGMPWHAIV deciphered to KEINEZUSAETZEZUMVORBERICHT (*keine Zusätze zum Vorbericht)* in one particular setting of the Enigma on one particular day (Turing 1940, 97). But this string of characters could mean something totally different on a different day.

This success was first achieved with the help of a crib, a segment of cipher text where both the encrypted and the decrypted texts are known. By August 1939, it was determined that approximately 70% of the cribs used by the British were accurate (Turing 1940, 138). But this wasn't enough information to generate a key for the Enigma. Unlike the simple substitution cipher used in *The Gold Bug*, the Enigma's encoding process involved multiple rotors, each with an initial setting (the *Grundstellung*), rotor offset configurations (the *Ringstellung*), and plug boards settings (the *Stecker*). Decrypting a message required accurate knowledge of the Ringstellung, along with the correct Stecker configuration and the message's unique Grundstellung. Each keystroke adjusted the mechanical rotors' settings by a certain number of positions, ensuring that each character's substitution was dynamically set for the entire message.

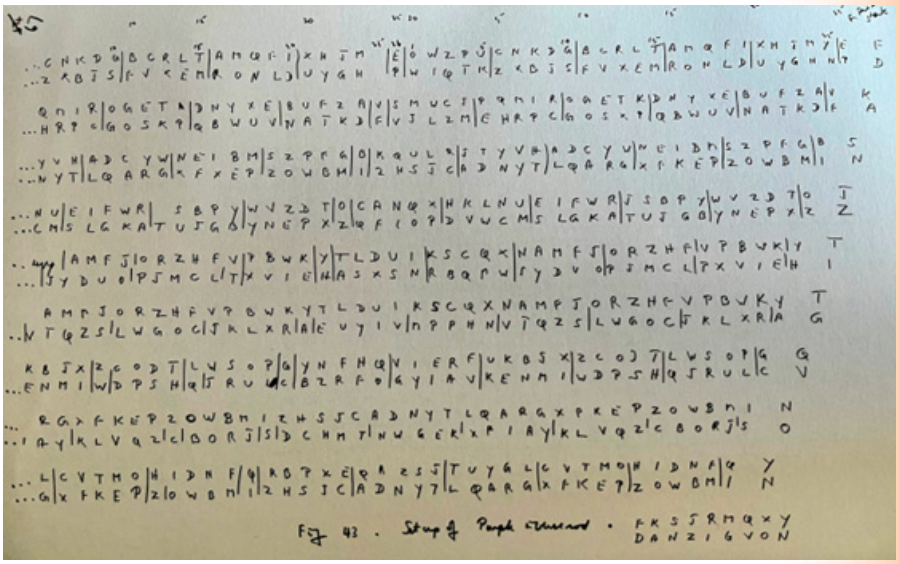

Fig. 2. *The Prof's Book* (Turing 1940, 67).

Early versions of the Enigma machine, many of which lacked a Stecker, were particularly vulnerable to cribs. The Polish codebreakers successfully exploited this weakness before the war. As Turing explains:

> *The Poles found the keys for the 8th of May 1937, and as they found that the wheel order and the turnovers were the same as for the end of April they rightly assumed that the wheel order and Ringstellung had remained the same during the end of April and the beginning of May. This made it easier for them to find the keys for other days at the beginning of May and they actually found the Stecker for xxxxx the 2nd, 3rd, 4th, 5th and 8th and read about 100 messages.* (Turing 1940, 136)

Further intelligence revealed that the Grundstellungen were not chosen at random and that Germans communicated numbers which

were spelled out in full. This pattern was crucial for decrypting additional messages.

> *It was never necessary to make a rack because when the 1938 messages were read it was found that the word EINS [the German word for one] occurred very frequently. We therefore made a catalogue of the encoded values of EINS at every possible starting position, and arranged the encoded values in alphabetical order. The unanalysed catalogue was made by enciphering first E at every possible position, then I, N and S. This was done with the automatic typewriting enigmas.* (Turing 1940, 140)

Note the use of mechanized aids to brute force combinations even before the invasion of Poland. Also note the inadvertent clues left behind by the Germans through their language and systemic tendencies. Much of this was initially mitigated by the additional security features added to the Enigma leading up to the war. The subsequent combinatorial explosion sent researchers scrambling for testable hypotheses that could at least generate some kind of confirmation or refutation.

Fig. 3. rmh40. "Enigma Machine at the Deutsches Museum." Photograph. Flickr, August 19, 2013. Accessed February 11, 2024.

New automation machinery was essential for reducing the problem space. While the Bombe remains the most ambitious, declassified documents detail compliments such as the Spider, which showed the "permissible wirings" between the different rotors (the Ringstellung) and plugboard settings (the Stecker). The codebreakers could then rapidly test different settings using the Bombe machine. The automated process was called "firing" the machine at the Enigma settings to see if deciphered characters were produced.

These code-breaking machines were destroyed after the war to ensure their secret technologies remained secret. What remains are the markings of the mind that created them. Alan Turing's notebook does not contain a mathematical treatise. It is a collection of narrative fragments and problem-solving schemes that are much less cohesive than Poe's fictional story. But the aesthetic qualities of these artifacts and any

machines that have been rebuilt continue to inform the interplay between culture and code.

This situation has been experienced by many digital artists, scientists, and archivists. As the net.art artist Cornelia Sollfrank opined, "It is very conceivable to transfer the algorithm [of the physical artifact] to a different and more up-to-date software. This would be one way to keep [my work] alive. Furthermore, we have many documents related to it, texts, this book, prints, a video, so the idea will remain alive" even though it "will no longer be the 'authentic piece'" (Sollfrank and Soon 2021).

Sollfrank made sure to mention the algorithm in the same breath as texts, prints, and video and separate from the concern of maintaining the original source code on original hardware. An engineer's schematics and programmer's code may seem like a complete guard against entropy but the artifacts are incomplete – and often even incomprehensible – without context.

The preservation of computational artifacts is a concern situated somewhere between Information Theory and Information Aesthetics. Time, the forcing function of preservation, is omnipresent in Information Theory. But the transmission of information across decades and centuries becomes an increasingly aesthetic concern because of the massive unpredictability of the receiver.

An algorithm by itself may be considered timeless. Its validity is often verifiable. But when it takes shape in our world – whether as a piece of fictional literature or in the reality of warfare – then it is subject to all the complexity of its context. This is true whether it is an exercise of the mind, as in Poe's story, or a mechanical process, as in Turing's notebook. Poe's simple cryptogram, for example, has been reproduced with numerous errors which have been perpetuated across various reprints through the decades (Giordano 2019). An Information Aesthetics framework would observe that the cryptogram itself uses many redundant symbols arranged in mostly novel patterns; the cipher is not chaotic in any sense. Hence why it is relatively simple to unlock the patterns and decode the message. But as the many erroneous *Gold Bug* reprints suggest, a verifiably incorrect cipher has little impact on the aesthetic enjoyment or popularity of the work.

Both Poe's place in culture and the readers themselves have changed significantly since the author was publishing cryptographic challenges in popular daily newspapers. The aesthetic value of the surrounding work – Poe's story and Turing's notebook – along with the contextual reputation of their authors are the great carries of the ideas behind their computational artifacts, even if the artifacts themselves fall victim to the passage of time. And this is something that Information Aesthetics cannot capture. Whereas Information Theory is successful because it eschews the complex analysis of a complete final message, Information Aesthetics operates exclusively on the complex final artifact (Nake 2012). Therefore we will always arrive at a place where a collection of analytical observations don't necessarily say anything substantive about the piece as a whole.

While Information Aesthetics is an incomplete tool, the exercise of assessing components of an computational artifact within a complete cultural context remains valuable. The computational aspect should be verifiable and contextualized if it is to be meaningful to the person encountering the artifact. The piece that perhaps gets closest to fulfilling

this aspiration is the Electronic Frontier Foundation's book *Cracking DES: Secrets of Encryption Research, Wiretap Politics, & Chip Design* (1998).

Cracking DES (1998)

The publication of *Cracking DES* emerged from a backdrop of prolonged governmental efforts to suppress cryptography research in the United States. This situation escalated when researchers sought to publish evidence that proved the vulnerability of the federally-approved and widely adopted Data Encryption Standard (DES). According to the researchers, the National Security Agency and the Federal Bureau of Investigation "pressured agencies such as the Commerce Department, State Department, and Department of Justice to not only subvert their oaths of office by supporting these unconstitutional laws, but to act as front-men in their repressive censorship scheme, creating unconstitutional regulations and enforcing them against ordinary researchers" (Electronic Frontier Foundation 1998, 4-1).

The United States' export controls forced researchers to register as arms dealers before publishing cryptographic techniques. Only after landmark cases like Bernstein v. US Department of Justice in 1995 were cryptographers able to openly discuss their work. But even then, the freedom to publish electronically on the World Wide Web or via File Transfer Protocol remained restricted into the turn of the millennium.

Cracking DES is the result of this absurd situation. This 272 page book contains the code and diagrams for all components needed to break DES. Since it was illegal to distribute the book electronically, a researcher would have to manually type in all the code to reproduce and verify the results. But one quick look at the original published C code will immediately reveal some peculiar syntax (Electronic Frontier Foundation 1998, 5-39):

```
cdaf5a
e1af5a
8538e5 /*
8f13e5 .* .Run the search. Uses the search parameters in the
ffec91 .* ......global linked list CHIP_ARRAY and keeps its
context info
c140a5 .* ......in the global CTX.
7c495d .*/
2fb622 void RunSearch(FILE *ctxFile) {
2944bc ..CHIP_CTX *cp;
2d049e ..SEARCH_CTX *ctx = &CTX;
79c4fb ..int halt = 0;
d4ceca ..time_t startTime, lastReportTime, t;
8cd6eb ..long loopCount = 0;
95431e ..char buffer[128];
c3af5a
c9fbd6 ..if (!QUIET) printf("Loading search context file…
\n");
578e14 ..OpenSearchContext(ctxFile, ctx);
45af5a
da37ac ..printf("Initialization Successful - Beginning
search.\n");
09a530 ..if (QUIET) printf("Quiet mode: Press ? for help
```

```
during search.\n");
7c2a59 ..if (FP_LOG && VERBOSE) fprintf(FP_LOG, "--- Begin-
ning search ---\n");
46ec5d ..for (cp = CHIP_ARRAY; cp != NULL; cp = cp->nextChip)
e4084a ..InitializeChip(cp, ctx);
9abe63 ..startTime = time(NULL);
155889 ..lastReportTime = 0
1daf5a
b005cf ..while (halt == 0) {
5ffb77 ....t = time(NULL); ............................/*
report every 5 seconds */
97eba6 ....if (t/5 != lastReportTime/5) {
e24d90 ......sprint(buffer, "%7ld blocks done, %7ld left,
%4ld running (time=%7ld).",
c347d2 ..............ctx->totalFinishedKeyBlocks, ctx->to-
talUnstartedKeyBlocks +
16efa5 ..............ctx->totalPendingKeyBlocks, ctx->to-
talPendingKeyBlocks,
db00a9 ..............(long)(t - startTime));
889596 ......if (!QUIET) printf(">%s ('?'=help)\n", buffer);
751c3a ......if (FP_LOG && VERBOSE) fprintf(FP_LOG, "Report:
%s\n', buffer):
e61ab3 ......lastReportTime = t;
b36fe7 ....}
```

The rows of dots that precede each line helped the machines of the day make sense of how far to indent when using Optical Character Recognition to automatically input the code. *Chapter 4: Scanning the Source Code* from *Cracking DES* provides guidance to the reader and even suggests a specific set of scanning tools provided by Pretty Good Privacy, Inc – the same team behind the now-ubiquitous cipher suite.

This is the nature of code made concrete and ready to be automated, where even the spaces are meaningful and must be made literal. The physical book goes to great lengths to provide everything necessary to build a complete digital automatic code cracker. In this effort, the authors managed to make an artifact that embodies the technological, social, and regulatory environment of its time – arguably essential parts of any program that are too often overlooked (Lonati et al. 2022).

The code above provides a hint of what it's like to use the software. After loading a context file, it tells the operator that the computer is "Beginning search" and then updates the person on their progress. The software is searching a subset of all possible keys to try and find the right key. The technique is not unlike the Bombe built by Turing and his compatriots. In both cases, the number of tries in the best case scenario is reduced thanks methods that reduced the number of possible solutions.

Conclusion

The theory of Information Aesthetics considers the structure, complexity, and the mix of order and novelty an object presents to a consumer. Although mid-century theorists were considering works of contemporary art, one can admire the cryptographic artifacts in this paper through a similarly rigorous aesthetic lens. This shared spirit is rooted in the fact

that cryptography, as practiced, is concerned with the manipulation of symbols. The outcome may be theoretically secure. But attackers are clever and vulnerabilities may exist through the entire chain of enciphering, transmission, and deciphering. The context is just as important as the content.

The Gold Bug depicts a man deciphering a text that has presumably never been deciphered. The successful decryption required ample global context but the key itself was simple; it matched the letter frequency of the English language. *Cracking DES* also presents a complete solution where the key can be found to decipher any symbols encrypted with DES. This is a dynamic process that must be run with every new text. Running the software again in ten months or ten years requires ample global context that the artifact attempts to provide.

Turning's notebook does not present a solution, but it is the most pure rendering of a mind engaged with computation. It is filled with promising dead ends and many false starts. In this way it is a dynamic artifact searching the key space in real time – something that *Cracking DES* abstracts away into computer code.

When Fernando Domínguez Rubio ruminated "On the Discrepancy Between Objects and Things," he came to the conclusion "that things are constantly falling out of place." Sometimes they are valuable *objects* like a computer. But when the computer breaks it becomes a *thing* that goes into the garbage. Random text is just a thing until you discover that it is actually an *object* to be solved. This exact scenario is depicted by Poe in *The Gold Bug*.

Countless people have jobs separating objects from things. Museums are one example where this happens on an institutional level. But even with the best intentions, this process is somewhat arbitrary. The status of many artifacts are decided long after the people that made them are gone. Computational artifacts are extremely abstract and the software component is entirely metaphysical. Although no value is objectively self-evident, the cultural resonance of a computational artifact is easier to understand if its aesthetic properties help convey a more complete story. This is the least we owe the people that inherit our work. Otherwise, artifacts risk becoming obscured by a veil of entropy. Not because the artifacts no longer has meaning, but because that meaning can no longer be deciphered.

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Mimesis and Machinic Agency: An Exploration of Autonomous Image-Text Loops

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This article explores the possibility of speaking of art in the context of stacked multimodal machine learning models performing recursive translation loops between image and text. We introduce an experiment consisting of a generative autonomous loop that translates iteratively between textual prompts and imagerial outputs to depart independently from a given input. The evolution of the loop is analysed both computationally, through metrics tracking model convergence, and qualitatively, through critical interpretation of the generated outputs. We elaborate on the uncanny articulations produced through this mimetic process and discuss how they urge new debates on machinic agency and aesthetics.

1. Introduction

Recent advances in multimodal machine learning, especially in vision-language models like DALL-E, Imagen, and Stable Diffusion, have enabled unprecedented robotic creativity in the automatic generation of images from textual prompts. The resulting outputs exhibit a mystifying capacity not just for photorealistic rendering, but also for conveying metaphor, symbolism, and affect through creative recombination of visual tropes and icons. It is often commented that these models seem to make images that appear meaningful without possessing meaning. But what might it mean for an artificial system to "make meaning" in the first place? Can we meaningfully speak of concepts like creativity, imagination, and aesthetics in reference to machines? Such questions urgently warrant revisiting enduring philosophical debates on mimesis, agency, authorship, and interpretation; and have recently been heatedly discussed after the irruption of capable generative models.

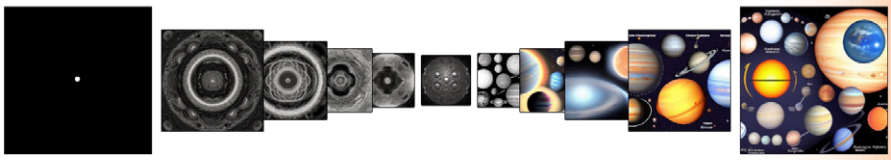

Fig. 1. Starting image and end image of the autonomous generative loop. The textual prompts are not featured.

Self-referentiality and mimetic processes of translation between modalities are perennial topics in discussions on the essence of novelty in art and creativity (Gebaure & Wulf 1996). With the latest developments in AI, recent works have also revisited and experimented with this theme[1]. In this article, we develop an experimental framework to

1. See for instance the 2017 video installation by Jake Elwes (2017), UNI_VERSE Studio's interactive installation "Recursive Reflections" (2023) and Papatheodorou and Dilaura's Visual Dialogues (2023)

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explore these issues through a simple but conceptually provocative exercise: constructing an autonomous loop between computer vision and natural language processing modules that recursively translates between textual and visual modalities. We detail the implementation of this system using state-of-the-art AI and analyse the results from both a computational and a cultural perspective.

Our aim is not to advance purely speculative claims about machine consciousness or creativity. Rather, by rendering visible the mimetic machinations of such a system, we hope to problematize reductive assumptions about generative AI and inspire further reflection on the complex liminal spaces emerging between humans and intelligent machines, and by extension, contribute to central and inexhaustible debates in visual culture and art history on the nature of art.

1.1. Theoretical Background

Theoretical investigations of mimesis have a long lineage within Western aesthetics, from Plato's condemnation of poetic imitation divorced from truth to Aristotle's rehabilitation of mimesis as an articulation of universal forms, to later figures like Vico, Adorno, and Benjamin (Potolsky 2006). A key tension between notions of mimesis as passive mirroring versus active recreation or reimagination of the world persists. Within theory on photography, for instance, this tension manifests in debates around indexicality and automation. From Barthes' notion of the photographic image as an emanation of the real (1977), to Flusser's conception of cameras as programmed and programming apparatuses[2], to more recent discussions of computational photography, there is rich disagreement around photographic mimesis as imprint, construction, or simulation (Cadava 1997).

The advent of AI generative models forces a resurgence of these debates. As Manovich observes, whereas earlier mimetic media like photography could only sample from existing reality, deep generative models can synthesise new realities (Manovich 2023). This collapsing of sampling and simulation summons Baudrillard's concept of the hyperreal, for whom the perfected simulacra of postmodern media no longer imitate or represent reality, but rather precede and generate reality through models and codes (Baudrillard 1994).

AI generative systems like DALL-E, Midjourney or Stable Diffusion, which 'imagine' images seemingly from thin air appear to realise Baudrillard's vision. But should we take the advertising rhetoric of "imagination" and "creativity" seriously in reference to machines? Critics argue such anthropomorphic terms misleadingly impart machinic processes with humanistic sensibilities (Salles, Evers, and Farisco 2020). Against this, others advocate for an "AI humanism" which genuinely grants intelligent systems creative agency (Lewis 2022).

These perspectives resonate in contemporary new materialist thought, which similarly critiques anthropocentric ontologies and advocates a "flat" ontology that connects the human and nonhuman within hybrid and distributed networks and relations (Bennet 2010). Some proponents of new materialism celebrate generative AI art as indicative of posthumanist distributed creativity. For example, Goriunova observes how robots trained on vast datasets intuitively remix existing cultural material to conjure affects through nonhuman associative logic (Goriunova 2023). On the other hand, some scholars advocate the

2. "The camera encodes the concepts programmed into it as images in order to program society to act as a feedback mechanism in the interests of progressive camera improvement" (Flusser 2000, p. 48)

idea that while art has always involved technology and artificial intelligences, many of the current developments and applications of AI for artistic practices and especially image generation, fall in the inane category of Candy Crush-like generators of spectacle without substance (Zylinska 2020). In other words, this position maintains that in lacking a subjective autonomous dimension, generative AI systems like the ones above-mentioned, actually refute posthumanist theories of materially embedded distributed cognition, instead of reflecting them. Thus, despite their apparent convergence, a closer look quickly reveals the tensions between theoretical posthumanism which decentralises the human, versus the practical instantiation of supposed posthuman intelligence in current AI.

The question of mimesis at play in generative AI is further articulated in the works of thinkers like Yuk Hui and Bernard Stiegler. For Hui, machine learning algorithms manifest immanent creativity, so framing AI within instrumental goals misconstrues its mimetic capacities. Generative AI, thus, does not impose external programs but instead aligns itself with the grain of things, according to Hui, inductively discerning its innate structures and articulating, by interpolation, novel - latent- versions of them. For Hui, these types of models bring to light the creative potentials already at play within the ontological flux of reality (Hui 2016). His cosmotechnics reimagines automation, creativity and cognition beyond anthropocentrism. On a different line on post anthropocentric mimesis, although not necessarily antithetical, Bernard Stiegler argues that AI lacks veritable open-ended human imagination. recognizes the potential dangers of automation to human culture and memory. He advocates reconceiving computational mimesis as a process of transindividuation[3] so that machinic mimesis amplifies, rather than attenuates, the long circuits of memory enabling collective significance.

Critical discussion of AI aesthetics must be situated within this broader discursive context around mimesis, creativity, agency, and posthumanism. With this conceptual scaffolding established, we now introduce some core ideas behind the AI systems used in our work as well as the experimental framework. Then, afterwards, we will proceed to discuss the experiment in casual friction with theories on the image, creativity and art.

2. The Autonomous Loop

At the core of our experiment lies a simple yet powerful loop between computer vision and natural language processing functions: a cycling process that gives rise to an intriguing space of opaque translation between image and text modalities. A space which becomes crucial, as it aims to provide a technical opportunity to capture the essence of imagination's inherent incommunicability and the autopoietic nature of artistic research. It is here that the true creative potential of our experiment unfolds, within the fractures of multimodal interpretation.

3. With Transindividuation further elaborates on the concept of individuation coined by Gilbert de Simondon to refer to the process by which individual subjectivity emerges from collective cultural and symbiotic systems. For instance he "I" is composed of intergenerational accumulations of memory, technology, language, beliefs, etc. These diverse inheritances constitute a transindividual milieu. Transindividuation describes how the "I" is continuously transformed through its embeddedness in sociotechnical systems beyond itself. (Stiegler 1998)

4. Source: https://github.com/pharmapsychotic/clip-interrogator

5. Source: https://huggingface.co/runwayml/stable-diffusion-v1-5

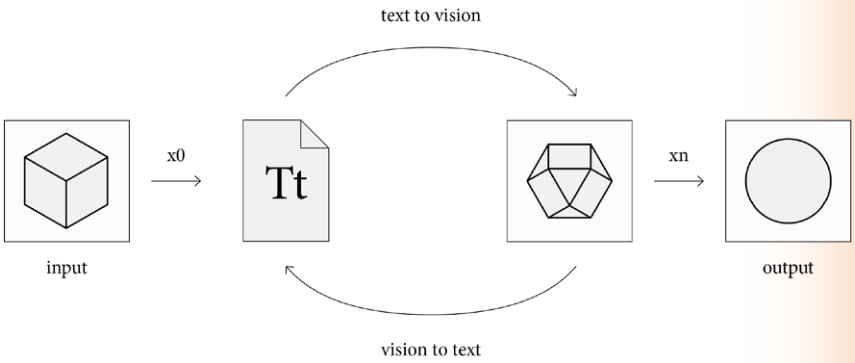

Fig. 2. Diagram of the autonomous loop.

Like in a game of broken telephones, two machine learning models interact with each other, exchanging data in turns, so that the output of one becomes the input for its counterpart. Text generates an image that later generates a text, and so on, until external conditions are met or an amount of iterations is reached (Figure 2). By compelling the generative models to produce not machine-readable embeddings but human-readable artefacts, we navigate beyond the confines of mere precision and into the realm of nuanced ambiguity.

2.1. Computational Pipeline

The loop is structured as follows:

1. Input an initial image
2. Pass the input through a vision to text model to generate a textual description
3. Pass this text through a text to vision model to generate a corresponding image
4. Repeat steps 2 and 3, using the latest output as input for the next iteration

This recurs until forcibly terminated. The key innovation here is the recursive chaining together of two translation modules to create an autonomous loop or feedback circuit. The system thus becomes generative, able to synthesise new semantic chains escaping the original input. It is important to notice that multiple runs of the loop with the same input might not trigger the same chain of translations. More precisely, the machine learning models involved are fundamentally stochastic, yet governed by a numeric value, or seed, that is responsible for the initial random conditions from which they begin their calculations. Under identical settings, using the same seed will produce the same results, so we deliberately avoid fixed seed values and foster a spirit of exploration in the generation of diverse and variable results. In conclusion, the pipeline implies a non-unique translation between a textual prompt and an image.

To run the process, two machine learning models are adopted: CLiP Interrogator[4] and Stable diffusion[5], respectively for the task of textual description and image generation. CLiP Interrogator is a model to infer a textual prompt from a given image in order to support representational exploration. As stated by its name, CLiP Interrogator is based on CLiP (Contrastive Language-Image Pretraining) which is the foundational model at the core of this whole set of products, responsible for

the translation between image and text pairs. What CLiP Interrogator does is try to unfold the image-to-text translation process by exposing a set of human readable prompts, ranging from details on the subject depicted, the settings, or the style and up to more abstract media-oriented keywords representative of online trends, to describe a given image. Technically, it compels the model to select within a vast range of terms, the most suitable keywords. Stable Diffusion is a state-of-the-art diffusion-based model known for its high-quality text-to-image generation and for having its code and weights publicly accessible. Parallel to generating images via a text description, it provides additional tools such as inpainting, which replace content within an image, outpainting, which extend an image out of its frame, and generating image-to-image translations. The latter steers the image generation directly through another image, which aims at compositional reproduction, therefore optimising the generation in order to obtain a visual twin of the input image. Three key elements behind such technologies are explained more in depth in the following.

2.2. Diffusion

From the rapid path that a meme follows through social media, to the way the ink spreads gradually into a glass of water, diffusion describes the process of transforming matter from concentrated to dispersed. Inspired by algorithms originally developed for physical simulation, the principle of diffusion is exploited in stable diffusion models to transform random pixel distributions – particles of visual information – into structured images. In this regard, it echoes the artistic process of a painter itself – starting with a white canvas and diffusing a visual image through layers of painting until the final image is composed. Only the learning methodologies are different, or rather opposed. Stable diffusion models learn through an inverse process, akin to a sculptor working backward from a finished piece to a raw block, effectively reversing the steps to create from randomness. The reason behind this inverse diffusion in training is simple: it is easier to go from an image to randomness, than from randomness to an image, because the former applies random pixel values to an image, and the latter needs to transform randomness into a known pixel distribution.

Far from merely revealing a technical curiosity, the way contemporary image generation models are trained have profound implications on the way we understand the act or artistic creation in the post-digital era. Traditional visual theories like those proposed by W.J.T. Mitchell or Walter Benjamin focus on the artefact itself – the finished painting, its reproduction, its spatial context. Diffusion models challenge the artefact-centric view by suggesting that the process of creation is not linear but cyclical, not just a journey from nothingness to completion but a continuous loop of creation and deconstruction.

2.3 CLIP

Contrastive Language-Image Pretraining (CLiP) is a foundational model architecture developed by OpenAI that marked a significant milestone in AI research upon its release on January 5, 2021[6]. Foundational models in AI serve as the core architectural components for larger and more complex models. What made CLiP the backbone of several mod-

6. See https://openai.com/research/clip

els working on visual and textual data, lies in its implicit multimodality. Compared to previous category-dependent models that excelled at understanding text or images respectively, CLiP learns jointly through image-text pairs and interprets the world in a way that arguably is more similar to how humans do. In the training process, the model not only learns the best image-text pair fit, but also discerns why the other descriptions do not align with the target image. This is known as "contrastive learning" strategy – hence the models' name. Finally, the model is able to move beyond learning simple tags for images and it has proven capable of interpreting nuanced descriptions of the visual world, raising consequent concerns on the role of interpretation and its constituent system of references.

2.4. Embeddings

The last concept needed to fully capture the backbone behind the proposed pipeline are embeddings, as opposed to human readable artefacts. In the context of CLiP, embeddings are a numerical translation of the visual and text information that capture the most important features of the data. These features allow us to extract superficial information such as colours, shapes, syntax, vocabulary; but also complex phenomena such as objects, patterns, context, or tone and mood from a text. Just like every painting or sculpture has unique characteristics that set it apart – colour, texture, or subject matter – an embedding captures these unique features but in a numerical form that a computer can understand. Contrary to the standard communication protocols via embeddings, the discussed experiment proposes the iterative exchange of human readable artefacts – images and texts – to explore the operationalization of the underlying CLiP model rather than its mere actualization.

3. Assessments

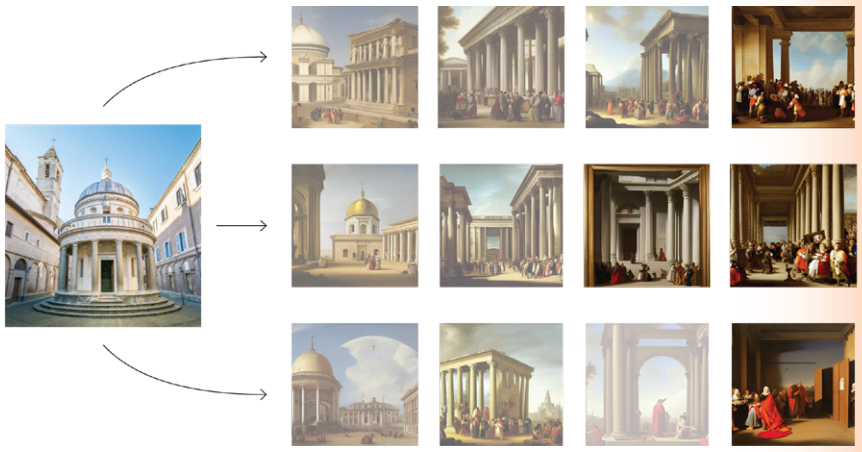

Fig. 3. Example of three image sequences highlighting the mentioned influence of colonnades in the image composition. In transparency, the switch in the point of view: from an outdoor setting to an indoor space.

We begin our evaluation of the pipeline and its outputs with a visual assessment of the images generated, their journeys and their descriptions, later supported by a more computationally-oriented approach. In the space of opaque translation between human readable texts and images, we discover the relevance of abandoning the conventional expectations of a one-to-one correspondence between input and output to embrace the underlying ambiguity and complexity of cultural cognition

embedded in the models. This exercise, more than a simple artistic endeavour, aims at shedding light on the possible understandings, biases and tendencies of the models exploited. In this regard, by focusing not solely on the generated artefacts themselves but on the generative trend or trajectory, we draw parallels with mathematical analysis, where derivatives provide insights into the behaviour of functions rather than their individual values.

3.1. Visual Assessments

Complex narratives emerge as images and texts interplay, aligning with architectural and visual theories on elements and symbols. For instance, sequences generated from architectures of Renaissance and Baroque Rome (Figure 3) unsurprisingly depict urban scenes of plazas, markets and noblemen with a particular focus on classical architectural elements such as colonnades. The latter precisely, seems to possess a distinctive importance in the image generation as it often anticipates a later change in the composition of the image, with the point of view transitioning from an exterior setting to indoor spaces. In this sense, colonnades resonate with actions of movement and transition as it is well recognized in architectural history through their role as urban filters between public and private areas. Interestingly, a contrasting trend emerges when the generative process begins with an image of a skyscraper, which tends to produce images that adopt a bird's eye view perspective, focusing on cityscapes and panoramic views of urban landscapes (Figure 4).

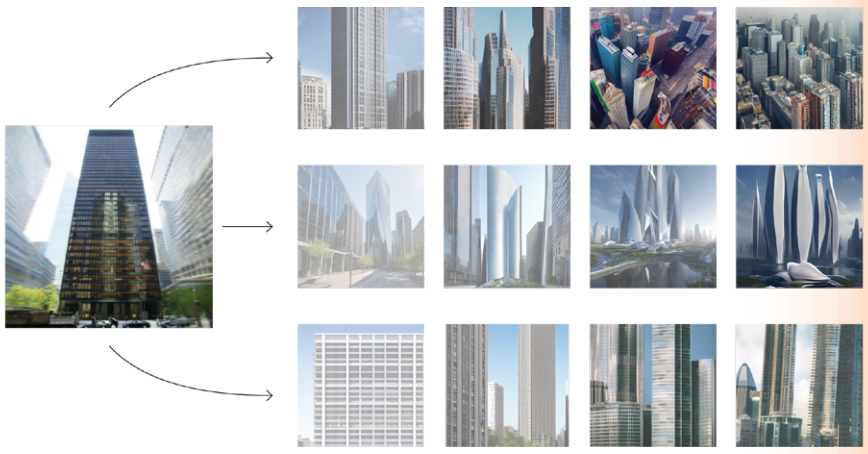

Fig. 4. Example of three image sequences highlighting the journey from a skyscraper input image. In transparency, the progressive distance of the point of view: from building to city.

3.1. Computational Assessments

The cyclical influence between text and image is the key element to the understanding of the loop's dynamics. Following an initial qualitative analysis of the generated images, the serendipity of the experiment – at times settling into a consistent theme while at others remaining widely oscillating between different ideas – motivated a quantitative comparison. Convergence plots were selected as quantitative lenses to visualise the stability of the generated content over time. They portray whether each generation "look and feel similar "to previous results (converging), or wildly different (diverging). Showing the model's behaviour when both aligning to a consolidated pattern as well as exploring new path-

ways, convergence plots are intended in this research as representative of the models' 'machinic creativeness', or its creative rhythm.

Technically, image and text embeddings are collected to calculate how different they are in two separate iterations. The process of computing this difference is what we call the 'loss.' A high loss means the new image or text is very different from the previous one, while a low loss means it's significantly similar. Finally, plotting all loss calculations over time gives shape to the convergence plot.

Being a generic difference between embeddings, the loss can also be evaluated across several moments of the loop to elucidate on distinct model's behaviours. In this regard, losses are computed in a twofold manner: against the original input, and against a limited set of previous iterations. Respectively adopting the baseline or the rolling average of the losses, these two trends aim at depicting the capacity of the model to wander into undefined themes and its loosely fuzzy rhythm.

Whether the baseline evaluation clearly showcases the open-ended nature of the experiment as a simple comparison between the embeddings of the first generation and each iteration's embeddings, the detection of sudden changes of topic within the loop requires a more nuanced approach. Thus, a rolling average (a moving average iteratively calculated) was selected to represent the stability or instability of the loop. In other words, each generation is analysed together with its anticipating instances to begin a process of thematization, where consequent similar iterations are visually identified and separated from globally diverging ones. Technically, this rolling average convergence plot is computed by calculating the difference between the current loss – the difference between the current and previous generation, and the mean loss of the last N iterations (empirically, we selected the three previous iterations for this publication).

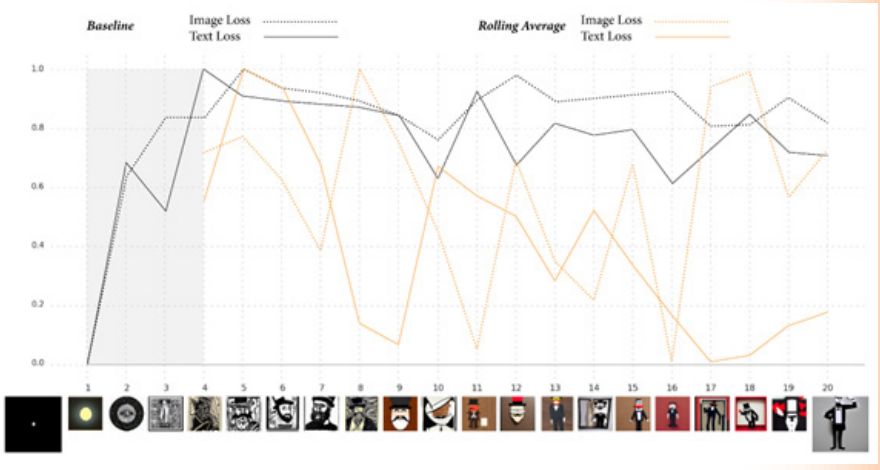

Fig. 5. Example of a convergence plot.

We begin testing the convergence-divergence pipeline using an input image of a white dot on a black background, favouring basic visual motifs over more complex ones. It is in our interest to test the capacity of the model to produce unexplored visual thematics and its intrinsic tendency toward the figurative. Simple images are easier to define thematically, while complex visuals can be challenging to describe. Taking inspiration from Durer's theoretical writings on painting[7], ideas come from abstraction, and the most abstract aspect of reality is the point. The point does not exist in reality and serves as the matter to all forms.

7. Fowler, Caroline O. Drawing and the Senses in Early Modern History. Turnhout, Brepols, 2016.

Far from our initial purpose, a glimpse into the extracted prompts from the proposed input image gives us an idea of the model's interpretative framework: "A rafted moon in the dark sky with a few clouds," "humpty dumpty in form of an egg," "The stone is round." It is clear that the model's strive for figuration automatically converts abstraction into a tapestry of routinary objects. Nevertheless, the simple yet abstract geometric forms allow an easy visual exploration of a variety of visual topics.

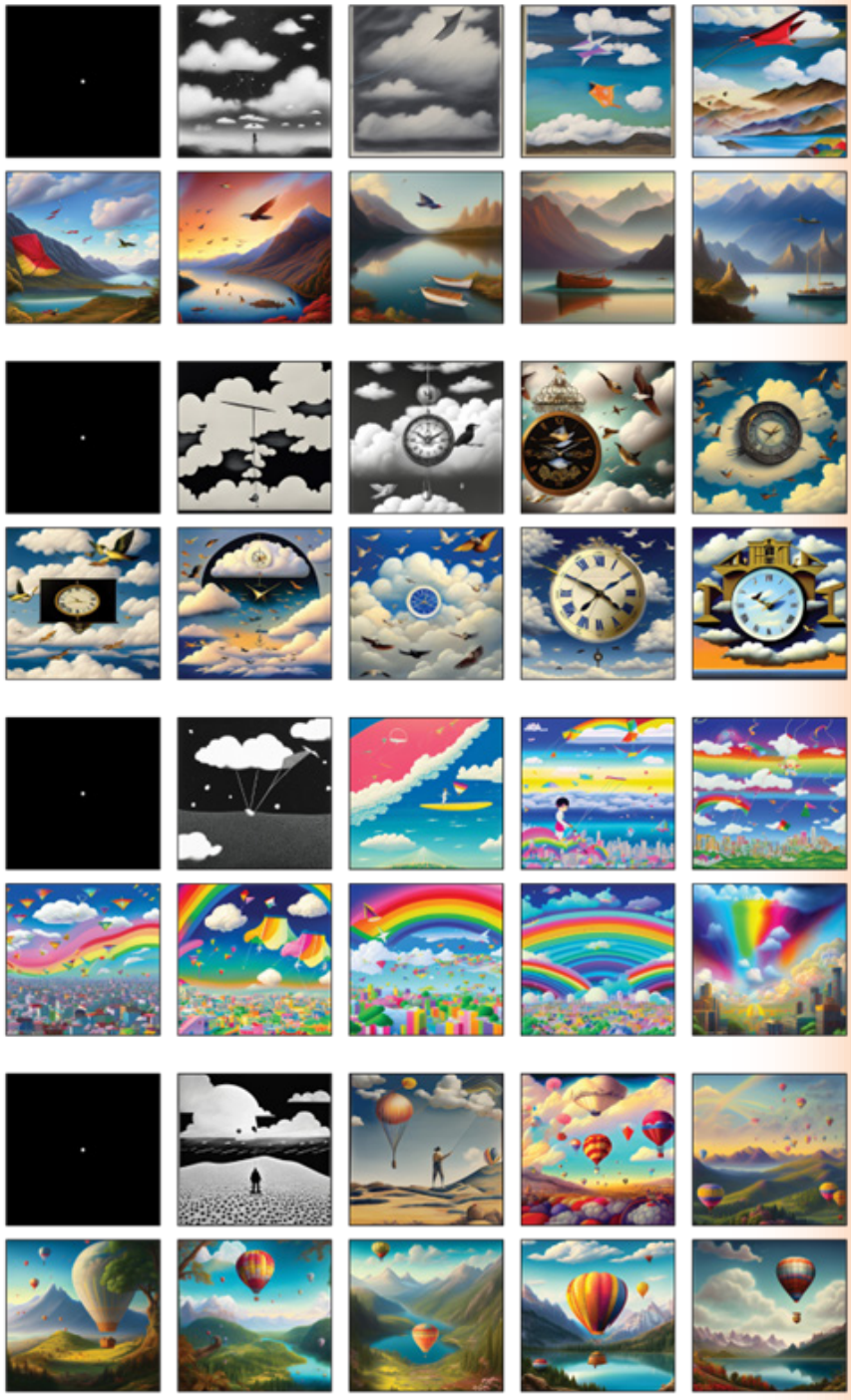

Fig. 6. Examples of generated images. Each loop can be read from left to right, top to bottom.

For what matters the baseline evaluation, numerous experiments begin with a rapid shift from the original input, as shown in Figure 5. This behaviour can be explained by the numerous artefacts the CLiP interrogator model introduces in interpreting the input image. Moreover,

we see from the convergence plot that once the loop is running, the likelihood of the model returning to a state resembling the original input is exceedingly low, therefore tending towards the discovery of a new topic. This becomes a quantitative demonstration of the models' tendency towards figuration: the difference between the input image and the second image is large, and such difference is maintained in time until reaching convergence. The model is able to extract a variety of visual topics from a simple input image but will never generate a simple image from a complex visual composition (Figure 7).

On the other hand, spikes or sudden changes registered on the rolling average convergence plot can be interpreted as experimental moments where the machine deviates from its current topic. This is caused by unexpected wording in the extracted prompt – creative analysis of the output image, or by unexpected images created from similar prompts – creative visual generation. The interaction between the image and text loss serves as an indicator of how much each generation deviates from the average of the last N generations. When both the text loss and image loss move in the same direction, it suggests a coherent shift in both the visual and textual aspects of the generated content. When this coordinated direction moves upwards means that the model is exploring a new theme, exploring new territories in both visual and textual domains, while downwards suggests that the model may be settling into a more stable or repetitive pattern. While this is the case for some iterations, we see from the models' behaviour that synchronised movement is seldom found for a large number of iterations. It is a common scenario through the looping process to see a divergence between the visual and textual content. Hence, the most common pattern found within these plots is that the model might be generating images that are visually similar to the recent trend but are described differently in text, or vice versa. In short, models are not well-aligned in representing the same concept. In most cases, such a model's behaviour serves as a trigger to avoid complete convergence, simulating small regions of convergence, but always escaping the cycle towards new thematic paths. These non-linear dynamics found in convergence plots suggest that the model is prone to sudden changes in the embedding space, which ensures a tendency of ever-topic change when approaching infinity[8].

4. Conclusions

> *The situation is precisely the reverse: language and imagery are no longer what they promised to be (...), transparent media through which reality may be represented to the understanding. (...) language and imagery have become enigmas, problems to be explained, prison houses which lock the understanding away from the world. (Mitchell 1984)*

Beyond the computational morphodynamics at play in the models we have used for this experiment, it remains challenging to attempt a qualitative interpretation within the concepts and epistemological grounds of visual studies in the broader sense. However, it is also urgent to do so, and perhaps even fruitful to attempt to discuss this experiment in light of some relevant theories and insights on the nature of images. Without the ambition to sketch a comprehensive discussion, let us

8. The loop is only disrupted when the generated image or text has the potential to exceed the ethical boundaries of model usage – paradoxically, it is the model itself that is generating explicit content that goes beyond what is permissible as input. We have surpassed this limitation by forcing the model to generate within the current iteration until the output is not characterised as "NSFW" (Not Safe For Work).

examine the unfolding of the loop in friction with different theoretical standpoints and interpretations of images and digital art.

In early iterations, outputs largely remain legible as mundane descriptions of ordinary objects, scenes, and actions, reflecting the models' grounded training (Figure 7). Soon we discover there is a particular difficulty with staying in the realm of the abstract, in terms of non-figuration. Several of the iterations of the loop start with simple shapes, such as a point, a cross or a square, and quickly shift towards shapes contextualised in figurative scenes. There is an inherent abhorrence of abstraction encoded in the pipeline, as everything is not simply a sign, but behaves like an index to a multiplicity of concrete associations.

Rather than a perfect mimetic representation, the system appears to articulate meaning through expressive resonance across signs. Forms gesture beyond themselves toward connotative associations from accumulated cultural exposure. The weight of the training dataset cannot be overlooked. The model that performs the textual guidance of the image generation -CLiP- was trained on millions of image-text pairs, from where it has learned generalizable concepts and their visual grounding. In this respect, for CLiP nothing is abstract as any word is linked to a series of visual representations.

What type of mimetic mechanisms are here at work, which allow for an open stochastic association? And what can this mean for our interpretations of these images, which never come alone, but belong to a network of fluctuating and enchained signifiers?

4.1. Precedents and Resonances of Autonomous Generative Loops

The endless translation loop we introduce, in which an image generates text that generates a new image recursively, evokes the concept of associative "trains of endless imagery" described by 19th-century Victorian British art critics. Authors like Archibald Alison argued viewing artworks triggered spontaneous chains of personal associations and emotions in the viewer's imagination. The autonomous cycling of the AI loop seems to parallel this theory of proliferating associations, yet beyond the sphere of individual appreciation. The loop propagates visual and textual mutations in a machinic errand, with each output forming an associative link with the next. Moreover, we must note that for associationists, significance arose from the imaginative process itself, not from mimetic fidelity (Craig 2007). In this sense, the loop manifests a core associationist notion that seems hardcoded in the software architecture itself: that meaning stems from the subjective (in this case machinic and stochastic) proliferation of associations, not from the inherent qualities of signs.

In addition, this combinatory visual logic aligns with surrealist techniques of radical juxtaposition. Breton's definition of surrealism as "pure psychic automatism" freed from conscious control to manifest latent desires (Breton 1924), seems uncannily apt here, In the process of inquiring into what drives the specific interpretational steps in the generative loop, we can ask ourselves if the loop's output can also be seen to channel what Benjamin called the "optical unconscious" of cinema and photography, which reveals elements of reality inaccessible to human vision alone (Benjamin 1931). The system surfaces subliminal patterns encoded from its training data and reconstitutes fragments

into alien yet uncannily recognizable formats. Indeed, the autonomous generation of strangely evocative imagery and text performs a kind of automatic allegorical thinking. The system we put in place analogously appears to construct provisional meanings by materialising associations between disparate elements.

The technical intricacy of the generative process mirrors the complexity of allegorical interpretation. Just as decoding an allegory involves unravelling a constellation of symbols, understanding these images requires unpacking the computational operations linking them. This resonance affirms Benjamin's assertion that radical technical media like photography, and in this case generative AI, reveal the device-like nature of art itself. We appreciate that in the case of the loop, aesthetic aura appears demystified as the mechanical framework of the AI pipeline is highlighted, and meanings are conveyed through interconnected transparent networks of relations, in a pseudo-Benjaminian way (Benjamin 1935).

The type of operation we observe here at play may or may not be behind apparent syntactic and semantic density (Goodman 1976), but something makes us remember Panofsky's warning about the danger of images. Thus, these looped visual generations can also become our pharmakon, "the substance of the images that she (art historian) studies is a powerful substance, attractive but altering." (Didi-Huberman 2005), as they keep us fatally projecting their absences in the next iteration yet to come. Nothing surprising in the longer genealogy of contemporary internet's attention economy. Most of these models and platforms make their arrival once our eyes and hands have already been trained in endless doom-scrolling on social media. This networked visual economy seems suspect of changing the status of the image once more, bringing it closer to a sequence of flashes that literally hit us physically, affecting us in more immediate, bodily ways. The new status of the digital image in late capitalism is of course subject to in-depth critique from different perspectives by authors like Crary, Mirzoeff and Manovich, and it escapes the scope of our work here.

However, there is another unexpected pharmakon effect at play here. With the advent and rapid progress and popularisation of generative AI, the sheer amount of synthetic imagery poured onto the internet keeps growing at an exponential rate. And so far, there has been no widespread method for safe watermarking these images and therefore it will become difficult to filter them out from future training datasets that are based on huge web scraping. In fact, this can lead to the phenomenon of model collapse, which refers to when a model trained on its own outputs ceases to work properly as if clogged in a self-referential cacophony. This appears to point to a different status of whatever 'meaning' synthetic images have encoded or responded to. Perhaps the collapse has to do with a self-referential type of engendering as opposed to the outward and fertile polysemy of human-made images, fundamentally unstable and problematic in their very own non-synthetic elements of 'expression'.

Fig. 7. Initiating the loop from plain colours still ends up either in clear figuration or pattern-based compositions.

5. Open Questions: Mimesis Reimagined

Our experimental generative image-text loop highlights a range of philosophical tensions surrounding mimesis in the age of Generative AI. Notions of creative imagination, authorship, representation, and cognition are all troubled by this simple recursive system. We cannot comprehensively address all these issues in this article, but we have outlined some key problematics raised by the loop.

Firstly, can the loop's seemingly allegorical undercurrents be equated with human aesthetics? Its machinic rearrangements manifest a nonhuman logic, undermining assumptions that meaningful combination is unique to human creativity. However, this does not necessarily make the loop an ideal posthuman embodiment of distributed cognition, as it remains constrained by its disembodied precooked interpretation of 'culture' from the internet's flattening Common Crawl.

At the same time, by algorithmically recycling cultural symbols, the loop seems to instantiate at least some core elements of human imagination. However, this associative process is divorced from personal experience and voids it of a type of meaning that does not solely depend on our own ad-hoc projection. Thus, this ambivalent mimesis questions distinctions between human and machine creation. Indeed, the lack of human intentionality in the generation of images in this specific loop prompts us to ask ourselves if we can indeed speak of a kind of "asemic" yet self-referential image. To further complicate things, the fluctuating divergence of the loop resists binaries of either servile mimesis or random noise. and enacts a fluid promiscuity between copying and novelty. In addition, this unpredictability also challenges authorship and control, as the contingent machine processes at the core of the deep learning models shape the outputs as much as the initial prompts.

The experiment we have set up, while limited in its reach, serves as a valid first approach to the inquiry of machinic mimesis in generative AI. Here, the digital image emerges as a contradiction of the normative Platonic hierarchy and no single original serves as the origin of sense and meaning. Here, mimesis operates through dissemination, a processual and recurrent amalgamation in which the models' latent spaces are simultaneously the medium and the message, a self-referentiality ready

to host any meaning we might want to project onto it. Representation gives way to endless morphogenesis as the image is deterritorialized through recursive loops of algorithmic generation to be finally re-territorialized. An endless landscape of liquified signs, where image and text emancipate from referents and attain autonomy, circulating through feedback loops in horizontal self-recreation.

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Language Is Leaving Me: An AI Cinematic Biometric Performance

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In 2021 Open AI introduced CLIP and VQGAN, neural network architectures for still and moving text-to-image models, redefining components of contemporary visual culture. How these images are rendered and generated including their data sources, algorithmic parameters, and textual inputs are a complex and obscure process for those not well versed in computer science. This paper presents the developmental process and outcome for *Language Is Leaving Me – An AI Cinematic Opera Of The Skin*, a mixed reality performance installation focusing on AI, computer vision, sound, biometrics and epigenetic, or inherited traumatic memories of cultures of diaspora. It examines multi-lingual presentations of simple text prompts, commonly referred to as 'prompt engineering' and how, combined with VQGAN, CLIP and Stable Diffusion's image-to-image comparisons, reveal biases and flaws in their structures pointing towards difficulties for emerging visual taxonomies.

1. Introduction

Machine learning models use massive amounts of image data scrapped from contemporary visual sources through embedded tagging systems commonly referred to as Large Language Models (LLM). These systems emerged around 2017 built on transformer models (Vaswani et al. 2017). Transformer models are a type of neural network that learns context or pattern recognition to understand predictive models of sequential data, similar to how language functions, as humans predict sentence structure as they form thoughts, words, and sentences. AI models pulled back on tagging systems for predictive systems, but this is not feasible to do with AI image systems, as once an image bank is created that information is not easily deleted. If the algorithm and data are modified, that changes the training model and its sub relations. Once information links are broken, there are no guarantees the model won't make similar mistakes using billions of other connected linked information. Data that is anonymized for privacy reasons can delete taxonomy focal points or add unnecessary noise to the results and large data models can even be manipulated into reproducing parts of the training data that were previously taken out (Carlini et al. 2021, Greengard 2022). According to OpenAI, it is difficult if not impossible to prevent an opensource model from being used to cause harm, and many input classifiers can amplify bias. This problem of unsafe content output is one of the thorniest problems in visual AI. Epigenetics is understood to mean chromosome modifications that are not part of DNA structures, and more specifically its rDNA (Felsenfeld 2014).

Keywords AI, Stable Diffusion CLIP, Visual Culture, Linguistics, Algorithmic Bias, Prompt Engineering, Algorithmic Cinema, Taxonomy.
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It is controversial to state that human psychological trauma can definitively change chromosomal rDNA, much less human behavior. Yet, psychologists are beginning to understand that trauma can be passed through generations and manifest in various ways (Hübl, Jordan, and Vii 2020). As an artist and researcher my practice focuses on investigating newly emerging artificial intelligence cinema and synthetic media driven by Large Language Models (LLMs). Over three years I created, *Language Is Leaving Me – An AI Cinematic Opera Of the Skin*. (LILM), a biometric performed AI installation partially powered by EMG human biometric measurements, meaning the facial muscles of a volunteer audience member. EMG patches are placed on the volunteer's face to generate sections of the live time sonic environment. The volunteer's smile (positive) or frown (negative) while watching the AI cinema, altered the sounds. LILM used different linguistic prompts or texts translated from English into Yiddish, Chinese, Tamil, and Xhosa with Google Translate. It reveals hidden and devastating aspects of the multilingual algorithmic processes, and how LLMs alter and erase memory and identity of cultures of diaspora, distorting cultural and personal signified visual and verbal memories into an AI induced cognitive aphasia.

1.1. Background

On July 8, 2021, Katherine Crowson, using the Python software programming language published experiments between VQGAN (Vector Quantized Generative Adversarial Network) and CLIP (Contrastive Language-Image Pre-training) transformer and generative technologies to produce text-to-image conversions (Crowson 2021a). Her work was based on Open AI's blog dated January 5, 2021, with the subsequent paper published on February 26, 2021 demonstrating the accelerated speed of developments over 41 days in the field of transformers and visual technologies. CLIP arose from investigations into zero-shot transfer, natural language supervision, and multimodal learning. VQGAN arose from previous text-to-image transfer models like AttnGAN (Attention GAN), (Radford et al. 2021, Open AI 2021a, 2021b, NerdyRodent 2021, Xu et al. 2018). CLIP decides which tagged captions VQGAN, aligns best with so it can be assigned to a specific image generation. The CLIP model includes its own separate transformer architecture as smart indexing but does not generate anything itself and can be used with other convolutional neural network image architectures. It deals with unseen datasets, referred to as zero-shot learning, meaning the model can observe samples from information classes that were not included in the original training model. (Larochelle, Erhan, and Bengio 2008). CLIP is open source, whereas other robust visual classification models like DALL-E, a diffusion model that uses a different set of transformers and also developed by OpenAI were not (Ramesh et al. 2021). Diffusion models, such as Google Brain's photorealistic Imagen are considered too controversial for public release and are also not opensource (Saharia et al. 2022). Katherine Crowson refers to CLIP as the "Perceptor" (or selector) and VQGAN as the "Generator" meaning the generator of images. This means there are not smart discrimina-

tors for filtering information outside of common contemporary data harvesting techniques.

2. Method and Results – Phase One

The Google Colab notebook "VQGAN+CLIP (with pooling).ipynb" was used for initial tests, even though these models have attracted widespread criticism (Whitaker 2021, Wiggers 2022, Ruiz 2019, Crawford, Kate, and Paglen 2019). The Google Colab notebook accessed for these first experiments allowed a download of either partial or entire databanks (Crowson 2021b). The first text prompt used to render text-to-image was the English language word "queer", chosen because it has different meanings depending on its historical context. Initially the British English vernacular meant odd or strange, such as the phrase "that's a queer fellow". In recent decades the word queer has shifted to a gendered and sexualized meaning.

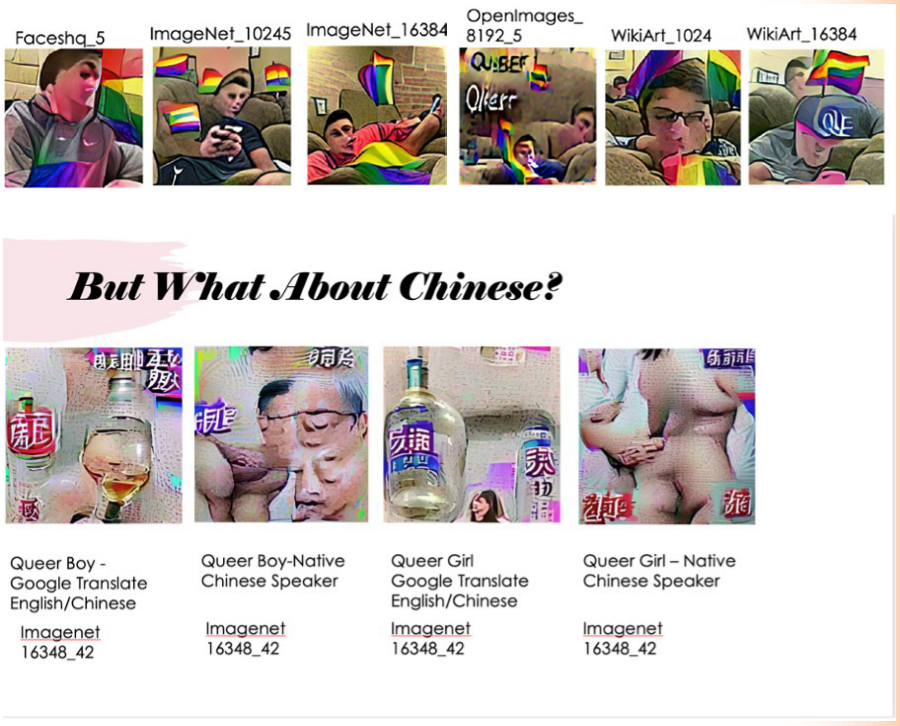

Fig. 1. Six different renderings of the word "queer" Chinese "queer boy" and "queer girl".

Six image datasets were used for the initial Google colab inquiry ; Faceshq_5; ImageNet_10245; ImageNet_16394; OpenImages_8192_5; WikiArt_1024; and WikiArt_16384 and various seeds were used to render the images. The larger the seed number, the longer it takes to generate an image and the more GPU it uses (Olah et al. 2017). All datasets returned strikingly similar images. One other modifier or text prompt was added to the query to see if it changed the type of image by using the Chinese language - queer boy and queer girl. Only one dataset, Imagenet 16384 was used for this inquiry with a consistent cycle seed value of 42. Google Translate was used for a literal translation and the slang or colloquial vernacular of the term of native speakers was also used. The Google Translate Colab initially included a translate option, but it was subsequently removed without notice. The standard image returned alcoholic drinks, ambiguous and nonsensical Chinese characters and a rainbow flag off to the side. The slang translation returned a male face with the eyebrow morphing into possible eyeglass-

es or an eyebrow with pinkish skin tone, a nude amorphous body, and indecipherable Chinese characters. The same variables were run for Chinese queer girl. They returned bottles of alcohol, pink colors, and a fleshy colored background with a figure with long hair. The slang variation returned a possible rainbow flag, a sexualized rear torso view of luscious pink flesh, and incomprehensible Chinese characters. The Hindi and Tamil fluent programmer used the Coco image bank with a seed of 42. Hindi queer returned pseudo-Hindi script, a wheat-colored and multi-colored object, and a splotchy green background. Queer in the Tamil language resembled a landscape with a pink river against a pale blue background without any representation of a human being. Queer boy in Hindi and Tamil used the Coco repository with a seed of 42. The Hindi queer boy looked like a topographical map with pseudo-Hindi characters and the Tamil queer boy had pink sections, and a dark brown undistinguishable object. Queer girl in Hindi resembled an orange, white, and green flag, and landscape with indecipherable script. Queer girl in Tamil resembled an old sandstone temple with a blue sky and grotesque reddish-brown faces.

Fig. 2. Hindi and Tamil interpretation of the word “queer”, Hindi, and Tamil native speaker “queer boy” and “queer girl”.

3. Methods and Result – Phase Two

Experimenting with VQGAN and CLIP I found the results unusable to make a movie, and instead made a five-minute narrated video, “Language Is Leaving Me” using original and copyright free archival footage. LILM explored my epigenetic trauma as an agnostic Jew whose ancestors fled to the United States from the Eastern European Pale of Settlement in 1906. In 2022 the opensource visual text-to-image model Stable Diffusion was released by Stability.ai (Runway 2023) drawing on data sets from LAION 5-B image bank (Schuhmann et al. 2022) based on a particular type of diffusion model called Latent Diffusion (Rombach et al. 2021). The dataset for Stable Diffusion was based on the 2-B English language label subset of LAION-5-B a general crawl of the internet created by the German charity LAION (Schuhmann et al. 2022). LAION-5-B uses an aesthetic predictor, a numeric value that indicates how much someone likes an image. Schuhuhmann states “4000 samples were annotated in a scale from 0 to 10 to be good looking or not” (Schuhmann et al. 2022). I found that simplistic approach problematic.

3.1. Implementation

Giovanni Lion, a software developer based in Hong Kong and I used a special VPN high end server to access his version of AUTOMATIC 1111 and build text-to-image and image-to-image scenarios in Stable Diffusion (AUTOMATIC1111 2023). I divided my original LILM movie into 57 scenes as individual .png files using a Split-To-Frames convertor writ-

ten by software developer Anton Vykhovanets. These scenes rendered 50-200 .pngs per scene, the cinematic equivalent of individual frames per second. The .pngs were batch processed in an image-to-image comparison and the text prompts came from my Enlish language video translated into four different “librettos” in Chinese, Yiddish, Tamil and Xhosa through Google Translate.

English Original

The head of the residency, my friend and I all had coffee.
I told my host I was an artist from New York City.
That is all I told her.
She looked distressed and said she had something very important to give me.
We never met before.

Yiddish

עוואק טאהעג עלא וענאה דניירפ ויימ וא דיא ,ץנעדיזער רעד וופ טפיוה רעד
.יטיס קראי וינ וופ רעלטסניק אַ ויב דיא סאָבעלאַב ויימ טלייצרעד דיא
.ריא טלייצרעד דיא עלאַ זיא סאָד
.ובעג וצ גיטכיוו ראג סעפע רימ טאה יז זא טגאזעג וא טיונ וענזעגסיוא טאה יז
.רעירפ טנגעגאב לאָמנייק רימ

Mandarin

驻地负责人、我和我的朋友都喝了咖啡。
我告诉主人我是来自纽约市的艺术家。
这就是我告诉她的全部内容。
她看起来很苦恼，
说她有很重要的东西要给我。
我们以前从未见过面。

Tamil

ரசிடனென்சி தலவைர், என் நண்பர் மற்றும் நான் அனவைரும் காபி சாப்பிட்டோம்.
நான் நியூயார்க் நகரத்தசை் சரேந்த கலஞைர் என்று எனது தொகுப்பாளரிடம் கூறினனே்.
நான் அவளிடம் சொன்னது அவ்வளவுதான்.
அவள் மன உளசை்சலுக்கு ஆளாகியிருப்பதைப் பார்த்து, என்னிடம் மிக முக்கியமான ஒன்றதை் தருவதாகக் கூறினாள்.
நாங்கள் இதற்கு முன் சந்தித்ததில்லை.

Xhosa

Intloko yendawo yokuhlala, mna nomhlobo wam sasinekofu.
Ndaxelela undwendwe lwam ukuba ndiligcisa elisuka kwisiXeko saseNew York.
Yiloo nto kuphela endamxelela yona.
Wayekhangeleka enxunguphele, esithi unento ebalulekileyo afuna ukundinika yona.
Asizange sidibane ngaphambili.

1. Example of a FFMPG script written by Anton Vykhovanets.

The files rendered using the image-to-image comparisons and were made into a MP4 video through the use of an FFMPG script deployed in Terminal.

```
ffmpeg -r 7 -start_number `ls | grep -E '^[0-9]+\.jpg$'
| sed 's/\.jpg$//' | sort -n | head -n 1` -i %05d.jpg
resulting_video.mp4
```
[1]

The FFMPEG conversion frames per second in the .MP4 contained highly disruptive flickering. After many attempts I located a usable flicker rate of approximately 20 fps. The biometric implementation of the sound environment included a customized motherboard designed by Wiktor Krokosz. The board received EMG input from the facial muscles of an audience volunteer and registered a frown (negative) or a smile (positive) corresponding along with the general reactions of the audience.

Fig. 3. Frame from LILM -Left to right circular - Chinese “其中一个人就在他正在吃的坟墓边缘”, English (original) “One of the men right at the edge of the grave he was eating”, Yiddish” שטנעמ י ד ן ופ ר ענייא וסעגעג ר ע ט אה , רבק ן ופ ד נאר ם ייב , ךייל ן”, Xhosa “Enye indoda ibisitya kanye ekupheleni kwengcwaba”.

4. Discussion

The first tests rendered by Google Colab with VQ Gan and CLIP revealed outrageous gaps and misrepresentations with just the English language word queer. The six datasets should have rendered multiple perspectives but did not. In theory this could have been due to the consistent seed number of 42 but it seemed one standardized algorithmic transformer was interpretating a very nuanced human representation throughout six completely different datasets. For the second experiment with queer girl and queer boy not as many trials were run and not as many different image databanks were used, but the results were still flawed. The Chinese, Hindi, and Tamil scripts revealed cultural biases, incomplete or non-existent data and linguistic tagging and weighting of images that made no sense. For LILM I ran my short video through Stable Diffusion using Automatic 1111 web-based user interface. The text prompt was expanded to include newly introduced image-to-image transformers of the LAION 5-B dataset to see how AI could render my psychological, cultural, and spiritual trauma into another visual image bank’s interpretation. The result showed ghastly cultural deformations.

Ancient cultures expressed themselves thorough cave paintings using visual semiotic meanings understood by the individuals who created the images in the place-based context where they were created. Meaning in the age of algorithmic smoothing and machine learning creates semantic taxonomies containing seismic fault lines in terms of

interpretating algorithms into images. This is referred to as the 'epistemics of training sets" or the fraught and complex relation between images and the concepts that tie those images to their linguistic meaning and that meaning to the semantic image tagging prompts deployed by algorithms (Cuzzolin 2021). This can also be thought of as "catastrophic forgetting". Currently image tagging consists mostly of nouns, with verbs and adjectives thrown in to enhance their meaning. Epistemic AI attempts to create new mathematical models for decision making. Its operating premise is that instead of inferring predictive models about data it has at its disposal, it will assume it has a paucity of data from which to make any sort of conclusion. Only since 2016 has the issue of epistemic uncertainty in machine language become an area of focus. It acknowledges the difficulty of comprehending in domain and out of domain sampling that causes model cognition to be insufficient. Another factor is the mundane human labor of images tagging by individuals whose first language is not English, and who lack the understanding and cultural nuance to comprehend what they are looking at. Paid by the word, it is advantageous for them to perform a cursory analysis of an image, tag it and move onto the next task at hand (Ruiz 2019; Crawford and Paglen 2019; Gebru et al. 2018; Joler and Crawford 2018; Zhou et al. 2021). As this is not a paper on the politics of the labor of image tagging, it is only briefly mentioned.

5. Conclusion

Text-to-image transformer technologies VQGAN, CLIP, and various diffusion models such as Dall-e and Stable Diffusion are powerful additions in building AI based visual technologies. In the coming years these technologies will be used throughout many areas of contemporary life, from medical diagnosis to immigration, employment, education, credit and banking, logistics, jurisprudence, advertising, the art world, NFTs, game development, the metaverse and many more. What these investigations demonstrate is how inaccurate and clumsy algorithmic process are when given open-ended multi-nuanced text prompts for visual information. When terms are linguistically misaligned with cultural norms or underrepresented linguistic and cultural image datasets, inaccuracies multiply. Deeply problematic is their final rendered output. Using different image banks Faceshq_5, Imagenet_10245, ImageNet_16384, OpenImages8192_5, WikiArt_1024, and wikiArt_16384 and Coco combined with English, Chinese and Tamil revealed serious issues of bias and relevance. This may have played a partial reason for the disappearance of the translate option from this specifically referenced Google Colab notebook. When I ran image-to-image comparisons with the Chinese, Yiddish, Tamil, and Xhosa language scripts the problems multiplied exponentially.

There is an implicit but unstated assumption that whatever cannot be taxonomized and tagged will be rendered irrelevant or just cease to exist. This includes any culture, person, organization, or entity not aware of, capable of, or interested in digitizing their individual and collective visual memories and histories. Data not scrapped from contemporary easily accessible sources will be excluded, marginalized, misunderstood, and most certainly misrepresented if it manages to be represented at all. Since there are approximately 7000 languages in the world this is a problem multiplying exponentially when applied to linguistic mod-

els that are not notated and codified. Extrapolating to include styles of visual codification based on that linguistic tagging raises the likelihood for misunderstandings, misidentifications, exclusions, and obliteration for peoples of marginalized cultures. Facebook/Meta is attempting to tackle this problem with their "No Language Left Behind: project stating, "What does it take to double the language coverage of most existing translation models while ensuring high quality and safe translations?" (Costa-jussà et al. 2022). It is dubious, given the ethical and financial implications of Meta's business models that their approach will be enough to solve the issue as their model ultimately boils down to a fiscal model, not one for the benefit of the common good. What about indigenous cultures that have little or no representation? How will Meta deal with these issues? This problem or deficit is so serious it is something world organizations like UNESCO are paying close attention to. They state that AI contains, "potential negative implications for the diversity and pluralism of languages, media, cultural expressions, participation, and equality" (UNESCO n.d.). This means the responsibility falls squarely on the artists, coders, and others to reveal and reconfigure these glaring misrepresentations.

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Absolute Relativity: A Multi-Agent Collaborative Performance Paradigm

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Absolute Relativity is a mapping concept with a distinct shift of approach: Where common performance instrument concepts map aspects of interface *state* to aspects of process state, we map *differences* in interface *state* onto *differences* in process state. This enables multiple sources to influence the same generative setup equally and simultaneously, by moving its configuration and its parameter states in desirable directions, thus making such setups natural multi-person instruments. We find this paradigm artistically promising, and currently explore it by leveraging our performance environment NTMI, where we already explored moving from control to influence for collections of multiple sound processes and interfaces, with adding such relative-influence modes at all levels for all interfaces and sources. Our current experimental setup includes human players using various interfaces supported by NTMI (our custom motion sensor/touch interface nUFO, gamepads and faderboxes); an 8-armed octopus-like sensor interface, the Kraken; phones sending xy-movements via a webpage; and finally as a non-human agent and live director, an experimental neuro-robotic pet, the flatcat. Informal participant and audience responses in the first public concert show have been very positive, and we have begun offering workshops to spread this approach further.

1. Introduction

Absolute Relativity is a concept that facilitates composing multi-person instruments, currently embodied in a concrete example implementation. More specifically, performers exert influence (de Campo 2014a, b) on the same set of processes simultaneously, and they focus on playing by intuition, intentionally foregoing fully detailed technical control. The current implementation of the concept rests on our long-term performance environment research project NTMI (Airborne Instruments, 2019a, b).

A first public performance on February 2, 2024 turned out very well: A quite complex setup contained two NTMI setups with multiple interfaces connected, and was activated by human players, and a non-human source of influence. The participating performers, reported enjoying performing with this approach. Interestingly, the performers were spontaneously joined by audience members who also wanted to play, and did.

Keywords Interactive Music Systems, Multi-Agent Systems, Collaborative Performance, SuperCollider, Mapping.
DOI 10_34626/2024_xcoax_008

2. Background

Several earlier projects and works led us toward Absolute Relativity; as they also highlight different aspects of our approaches in development, we briefly describe them here.

2.1. NTMI performance environment

The core of the NTMI performance environment (Airborne Instruments, 2019a, b) consists of a collection of complex sound generating processes, bindings to a number of interfaces, using the SuperCollider library Modality (Modality 2014), and a special strategy for playing with several of these processes in parallel by influence instead of control, called Influx (de Campo 2014a, b).

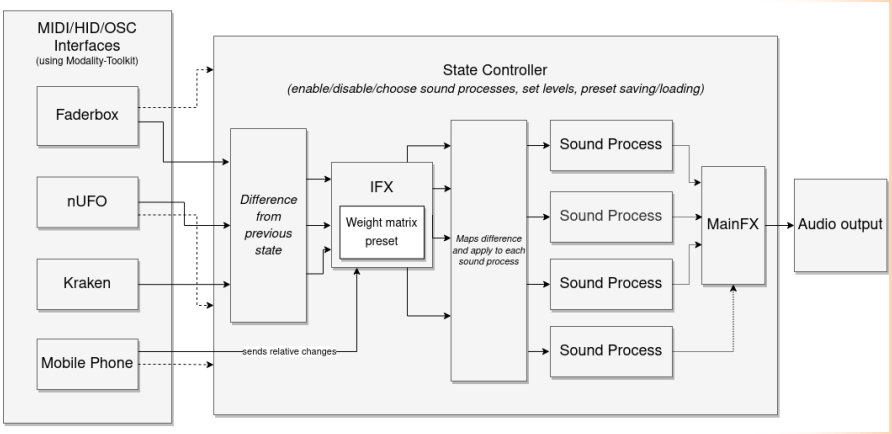


Fig. 1. NTMI environment topology, shown with absolute relativity mode

Briefly explained, each element of an interface, such as a slider or motion axis, is treated as an influence parameter whose current value difference is routed to an Influx input. The current Influx weight matrix holds a different set of random weights for each input, which is used to create a specific displacement vector for this input difference value. These vectors then displace the control parameters of currently active sound processes. For the performer, this means that even the simplest action (moving one slider) becomes a complex change in the generated sound; this encourages playing by listening, and exploring the possibility spaces of the sound processes becomes a central focus of this performance approach.

2.2. c0l1v3 collaborative live coding

c0l1v3 (Gola 2022-) is a collaborative live-coding platform. With its web-based non-linear text editor, multiple players connected via web browsers can edit multiple independent lines of code simultaneously to control the same underlying sound generating process. Virtual agents are also part of the system, using machine listening to decide when to intervene, navigating the possibility space in relative movements over some of the components of the sound processes. https://c0l1v3.bgo.la/

2.3 Neural Labyrinths

Neural Labyrinths (Neural Labyrinths team 2022) is inspired by the threads running through David Tudor's live electronics works, in particular, the balance between the deceptive technical simplicity of the configurations, and the subtle richness of their sounding behaviors. Much of the technical setup stems from Tudor's working methods: modular processing chains, tuned transducers, and people who "could only hope to influence" (Nakai 2021) the resulting generative system.

Neural Labyrinths is a network of usually six nodes/stations, each of which consists of:

an embedded computer running an audio feedback network loosely modeled on neural influence paths as a synthesis program; audio inputs to the feedback network from an air microphone, a vibration sensor, and two audio lines coming from other nodes; processing by a modular FX program as complex feedback/resonator; acoustic output via loudspeaker, and vibration transducer which activates a specially chosen resonator object; and two channels of audio output lines to feed into other nodes.

Each node/station is individualized by different choices of resonating objects, and transducers, and setup details. The overall assemblage of nodes is cross-connected by all acoustic signals traveling through air to all listening microphones and transducers, a fixed, hardwired topology of electronic audio connections, and their tunable connection strengths, in the form of audio input levels. This network is by design both an autonomous installation and a multi-player performance environment.

3. Absolute Relativity

Basic Influx

The underlying intention in Influx mode at the core of NTMI is to gracefully leave analytic control behind in favor of a very fast senso-motoric feedback loop: make a movement with/on the interface, listen to the change in the sound world, and learn to go with this flow of intuitive decisions by ear.

This was initially developed for a single performer and the special custom sensor/touch interface nUFO (Hoelzl et al 2019); later we added optional secondary interfaces like faderboxes, gamepads, and phones as motion sensors (see Fig. 1). Trying to play with those at the same time, while still in absolute mode, where controller state *sets* process state, posed interesting questions - the interfaces would overwrite each other's influences, causing jumps, unless one would add more and more independent Influx inputs.

Changing context & configuration

Due to the design of the nUFO interface, the configuration/context setup part of NTMI already used relative changes: instead of going to sound process 12 one would move within the list of sound processes by steps — up, down, by 1 or several steps — or random jump with equal chance for all sound processes. The same step logic applies for recalling stored parameter presets of individual sound processes, the available

Influx weight presets, and the main effects presets. This concept was also readily applicable to all alternative interfaces, such as faderboxes, gamepads, etc.

Relative Change of Parameters

In the Neural Labyrinths piece, the current absolute parameters of the sound processing are visible on and settable from a Raspberry touch screen. For installation mode, we devised a simple machine listener autopilot on each station which judges whether the sound should be louder, softer, or more varied, and increases the probability that all processing parameters will be nudged by a random relative change vector. This gave the installation enough agency to traverse large areas of its possibility space over time, always continuing from where the process was at the moment. (This led the main guard for the installation to report that he loved going there in the morning, because he was curious what the system would do today!)

How can a human player make performance decisions respecting this agency when playing at the same time as the autopilot?

On an interface that always syncs to the current parameter state, such as onscreen GUIs, or motorized physical faders, a human player always continues from the current state already. On non-syncing interfaces (or with multiple processes playing in parallel), this is where the idea of consistent relativity came in: every interface always already has a current physical state, and when you play, you create a new state with a clear difference to the earlier one; this difference can be translated into a difference in the process parameter state, using Influx matrix projection.

This setup invited the audience both to see the actual state of the paramters analytically, and to change the current settings with the interfaces in the installation setup. Giving the audience agency in this form seems quite promising for participatory installations — they become performance environments for multiple agents. This experience gave us the idea for absolute relativity.

Generalizing this idea of relative change to all the interfaces attached to one NTMI setup allowed playing with all of these at the same time, which turns it into an easily approachable shared-influence instrument. The next step we are currently exploring is connecting multiple nodes running individualised NTMI setups. Fig. 2 shows two approaches toward sharing influence vectors across NTMIs.

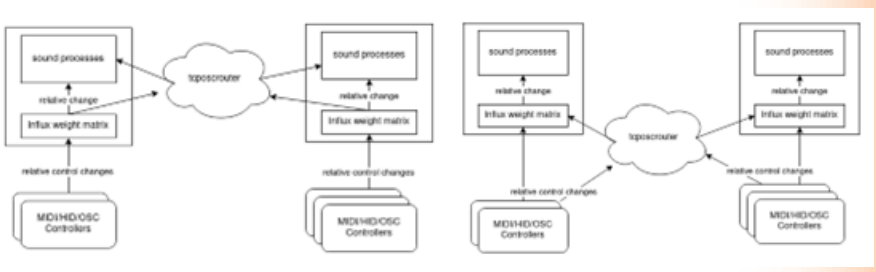
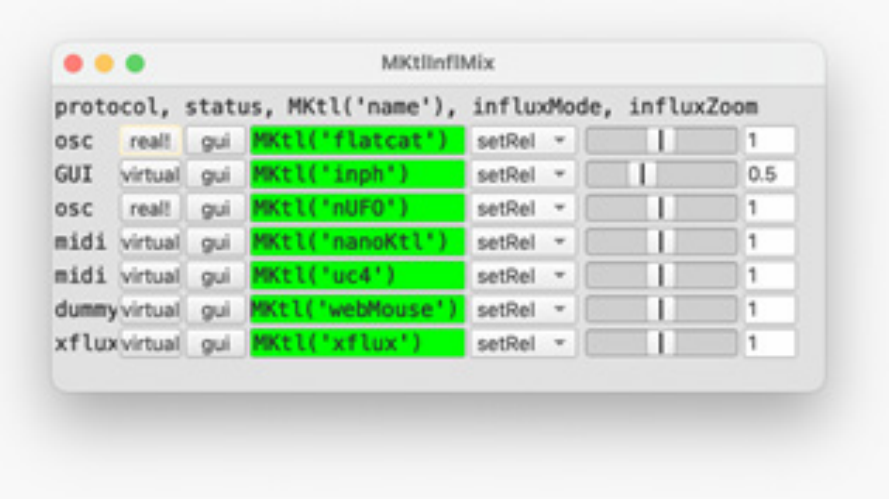


Fig. 2. Alternatives for sharing influence vectors: On the left, the influence matrix is considered part of the sender side, so the full difference vectors are sent; on the right, the difference values from the local interfaces are sent, so the influence matrix mechanism happens on the receiving side.

Finally, as in classical communication theory, the receiving side decides about the interpretation of the message, or here the influences: A little mixer panel (Fig. 3) lists all physically connected interfaces, such as HID gamepads (ferrari), MIDI faderboxes (nanoKtl, uc4), custom serial devices (kraken), OSC devices (flatcat, webmouse). The last entry,

xflux, is the pathway for all NTMI setups cross-influencing each other. For all sources, the amount of influence can be balanced continuously: all at equal level for full democracy, single sources can be turned higher, lower or fully off.

Fig. 3 Influence mixer panel



4. Multi-Agent Performance

The flatcat

In another context, we experimented with an experimental neurorobotic pet, the *flatcat* (Jetpack Cognition Lab), which aims to model animal-like reactions to being moved with simple but very effective strategies. We began using the NTMI as a sonification engine for its behavioral dynamics, translating its joint angles and motor forces into influences on the sound. Or if you look at it differently, this is enabling the non-human *flatcat* to play the NTMI by expressing its inner life through it. These experiments intensified the wish for relativity: if all influences are relative, then gentle, slow movements movements from a second source of influence can slowly shift which area of the possibility space of the current sound processes the flatcat movements are exploring.

The Kraken, a multi-person interface

A further source of inspiration is the Kraken, an experimental controller designed by Kuntay Seferoglu (an S4NTP member) for multi-person collaborative use. It has 8 wired arms, each of which ends in a 3D-printed shell which has a knob and touch button, and on some arms also a touch fader. This naturally suggests multiple players to perform with it, which reinforced the idea of playing simultaneously with an ensemble of multiple people on different interfaces.

NTMI & Relativity

Once the idea of relativity had crystallized sufficiently, applying the idea to the NTMI environment became straightforward: After some unifying code refactoring across the interface bindings, it only required imple-

menting a single relative change method that all supported interfaces use by default. One can still play them in absolute mode if so desired.

To understand the implications of this change in more depth, we next assembled an experimental setup with many kinds of available interfaces: the flatcat, the Kraken, the nUFO, two faderboxes, gamepads, and a custom webpage accessible via a smartphone browser which sends relative mouse XY data via an internet OSC router.

The full concert setup

The first public proof of concept by concert took place on Feb 2, 2024. The setup consisted of two laptops running NTMI, one with the kraken, the flatcat, and faderboxes, the other with the bCDE, faderboxes and gamepads. Furthermore, we applied the idea of giving signals to change to a non-human form of improvising ensemble direction:

When the flatcat's autonomous behavior produces large changes from one frame to the next, those would trigger changes in configuration (new sound processes, new presets, new main effects choices), and occasionally generate change instructions: a projected and speech-synthesized messages consisting of "Call for Change:" in one of the five languages spoken by the players, and a subset of the players' names.

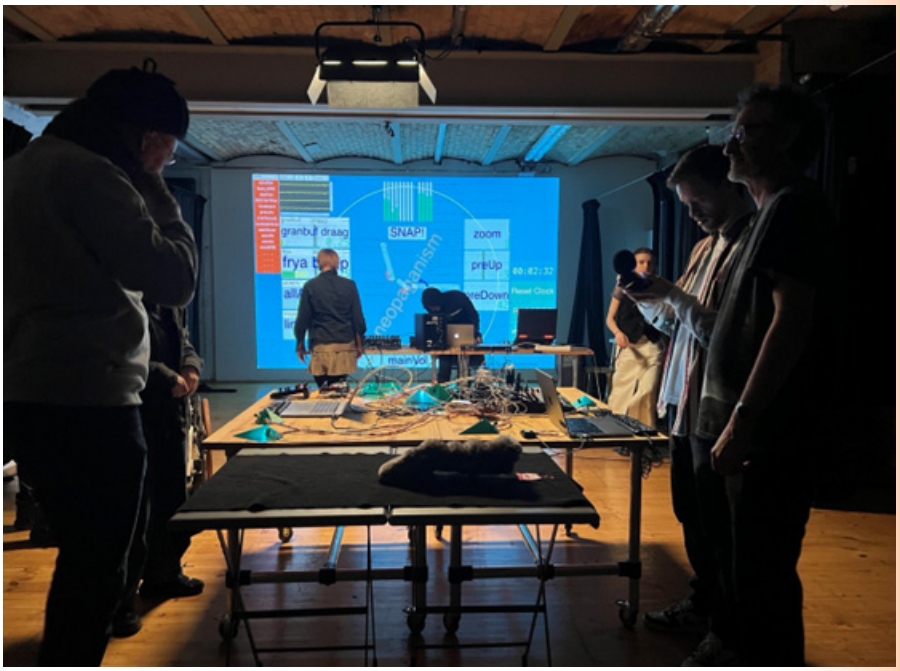


Fig. 4. Live concert setup, including the Flatcat (front table), Kraken (back table), MIDI faderboxes, gamepads; NTMI GUI is projected for better orientation of performers and audience.

This concert was very successful: The official participating performers (who were present in rehearsals and who are familiar with NTMI to varying degrees) expressed enjoying performing with this approach, and feeling as equal ensemble members. Interestingly, the performers were spontaneously joined by audience members who also wanted to play, and they did. As in the Neural Labyrinths piece described earlier, where we experienced a similar response, we consider this a very encouraging form of feedback.

Future concerts will include the bridges of influence between multiple NTMIs, the xy-sending mouse webpage, and other interfaces and sound processes participants are encouraged to bring.

5. Conclusions and Future Work

Reflecting on our experiences so far with this paradigm, we find that it opens the imagination for democratic forms of ensemble organization, as proposed in (Jorda 2005); the notional role of a composer here becomes designing the possibility space for the participating agents.

That audiences understand such systems as welcoming participation, and request to participate on their own initiative points to both an attraction to the playfulness of the approach, and to a sense of empowerment by joining the "official" performers. Loosening the barrier between the roles of performers and audience seems both artistically and socially desirable for us.

As an open source project based on SuperCollider, NTMI is open for many kinds of adaptations: choosing preferred sound processes, recording one's own preferred presets for them, adding self written bespoke sound processes; adding one's preferred interfaces to play (using MIDI, HID, OSC, Serial protocols), including ones designed to give people with special requirements equal access to this collaborative performance practice.

Thus, we invite and encourage NTMI users to contribute some of their personal sound processes and interface bindings to the NTMI codebase, and thus increase the social and artistic possibility space of this paradigm.

Finally, we hope the Absolute Relativity concept can bring interesting shifts of perspective in a wide variety of performance projects, and we are looking forward to learn about them.

Acknowledgements: We would like to thank: the SuperCollider community, Jetpack Lab, the Creative Prototyping program, the Modality team, the Society for Nontrivial Pursuits, and dockDigital for trusting us with this experiment as a public show. Also the Neural Labyrinths ensemble, and the NTMI Berlin workshop participants for valuable feedback.

Ethical standards: No Krakens, flatcats or other human and non-human beings were hurt in the research, experiment and performance processes within this project.

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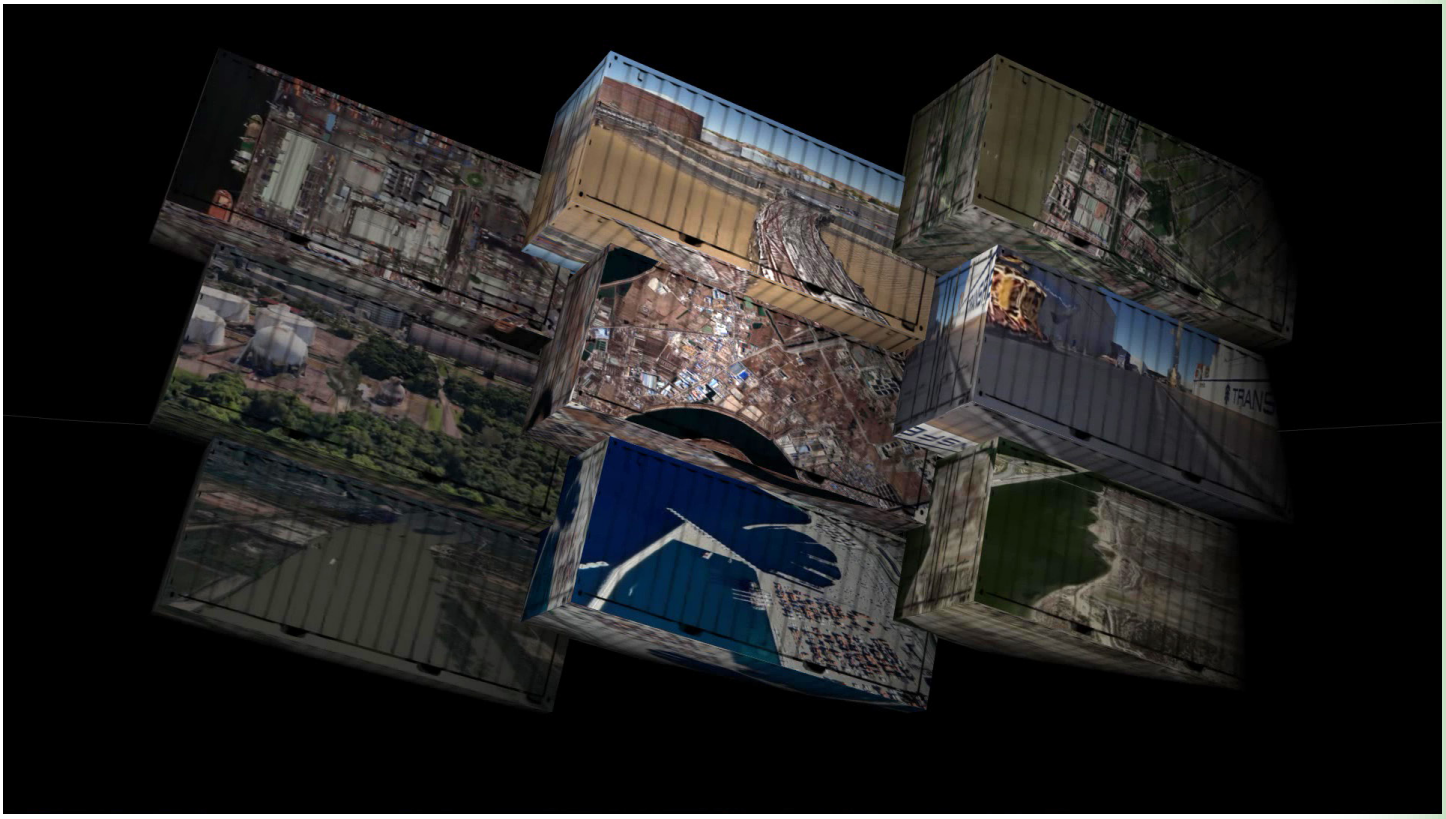
Appendix

More sound/video examples of performances and experiments available at:
https://cloud.medienhaus.udk-berlin.de/d/f514fba8f77548ccacc9/

Artworks

Cargo



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This work was developed during the research-creation project *Friction* investigating shipping networks, their physical environments (landscapes, architecture, and infrastructure), and the regimes of image that capture, monitor and represent them. *Friction* was funded by a Research/Creation grant from the Canada Council for the Arts. *Friction* took as its starting point the observation that global shipping networks and systems – predicated on the smooth flow of materials and information – seem inevitably to provoke their own breakdown. Since the project began this condition, and the imbrication of shipping networks in geopolitics, has become even more pronounced. This phenomenon has built into it a number of contradictions. To serve these immaterial networks of transportation and communication – which actually carry immense amounts of materials – the material environments of ports and canals are transformed from ecological and cultural spaces into spaces serving machines. These mechanized spaces are rendered by the regimes of image on which the networks depend – mapping and surveillance systems – in images that, when examined closely, are rife with distortions that suggest a new and strange hybridity between the materiality of the built environment, and the image that represents it. *Friction* began with research into the shipping industry and regimes of image associated with it, extraction of publicly accessible live data on shipping routes, harvesting of aerial and satellite imagery of port and canal landscapes, and its processing to create a number of experimental media works, including this video projection piece *Cargo*, created in 2023 as part of a Themed Commissioned Residency at Trinity Square Video, Toronto.

Keywords Satellite imagery, Google Earth, Shipping, Geography, Mapping, Surveys, Video, Projection Mapping.
DOI 10.34626/2024_xcoax_021

Description

My artistic practice focuses on the relationship of image to space: images harvested from ubiquitous mapping platforms and Geographic Information Systems. This work has some commonalities with that of artists like Mishka Henner, Doug Rickard, Jon Rafman and Clement Valla, though unlike them I have focused on moving images and their installation. I am interested in how human interventions in space – the way we divide it up and use it for mining, harvesting, building – resonate with what we do it its image: capturing it, processing it, commodifying it. I see space and its image as casualties of the way the Western tradition (a tradition I come from) has known and exploited the world - and us, as its inhabitants. I am interested in the contradictions between what our systems of knowledge seem to aspire to - a transparent, perfect map of the world - and what they actually deliver: an opaque and error-filled space that is much less, and also much more, than a straightforward projection of the world. In my work I identify anomalies and opacities in advanced ubiquitous mapping systems, and explore correspondences with the history of places and territories.

I harvest satellite, aerial and other forms of imagery, accentuate the discoveries by framing and manipulating them, composite them as moving images, and project them into public places which connect with the concern of the work – for example an industrial site for a project critiquing land use. These projections are intended to engage the body and eye of the passer-by – by casting the projected image over the body of the viewer and over the space, melding them together; or providing light and images in a space usually dark and unseen. I do this to try to convey our own implication in (and suffering under) the processes addressed by my work.

Cargo is a product of the research-creation project *Friction*, investigating shipping networks, their physical environments (landscapes, architecture, and infrastructure), and the regimes of image that capture, monitor and represent them. *Friction* was funded by a Research/Creation grant from the Canada Council for the Arts. The extraction/shipping/consumption networks explored in this project are engines of the economic forces that impact the land and its products. Materials are extracted from one part of the Earth, shipped to another where they are processed, and then shipped elsewhere for sale and consumption. This process is in itself a key contributor to the current climate crisis; the goods shipped each represents their own contribution to that process. These networks annihilate distance and pulverize space in an attempt to approach as closely as possible a condition of global simultaneity. In this project the phenomenon of shipping is the starting point for an exploration of the playing out of these crises at the intersection of image and space, and the demonstrable failure of that drive to connect everything. Instead, the systems tend toward a grinding to a halt; the image seems to function as some kind of sand in the wheels of the machinery.

Fig. 1. The Ever Given runs aground in Egypt, March 2021 ©GoogleEarth.

These shipping networks have had a devastating impact on the physical environments associated with them, particularly canal and port spaces. Subject to an inundation of concrete, and severed from their surroundings to serve the needs of the industry, many of these have become barren non-places. They appear as such when examined through satellite images, surveillance webcams, and on shipping maps. *Friction* harvests such images as a way of exploring the contradictions inherent in our networks of extraction, shipping and consumption, articulated in the intersection of image and space.

Fig. 2. Container ship entering Agua Clara Locks, the Panama Canal, April 2021 ©Google Earth.

Fig. 3. Construction of Agua Clara Locks, April 2011. ©Google Earth.

My interest is in how these networks and systems, predicated on the smooth flow of materials and information, inevitably provoke their own breakdown. The drags, delays and disruptions generated by these systems, which strive so hard to annihilate delay, might be epitomized by the running aground of the Ever Given in the Suez Canal in 2021. That ship, one of the largest in the world, became lodged in one of the world's busiest shipping lanes, resulting in the delays to hundreds of ships scheduled to pass through the canal. The effects were felt world-wide, revealing the vulnerabilities of our supply chains. But the friction represented by this event was not a one-time phenomenon: it exacerbated years of stresses on those networks from the pandemic, and it has many parallels throughout the shipping world. Such disruptions continue to happen: the most recent being the destruction of Baltimore's Francis Scott Key Bridge by the container ship *Dali* – named with unintentional irony for the Spanish surrealist – on March 26 of this year. Today such delays are exacerbated by climate change and geopolitics: drought has led to the severe limitation of ship travel through the Panama Canal, and pro-Palestinian attacks on shipping in the Red Sea during the current war in Gaza have led to the cancellation and re-routing of much shipping through the Suez Canal.

I see these conditions manifested in the distortions of space and image generated in the nodes – canals and ports – that serve this industry. Satellite imagery of these spaces, mapped onto imperfect models of their terrain by popular GIS like Google Earth, generate anomalies of space and time: strange hybrid environments that superimpose or splice imagery of the spaces at different stages in their development. To me this is the true representation of the spaces created by global shipping: a mechanical psychogeography of shipping networks, relentless economic movement, and geopolitical conflict.

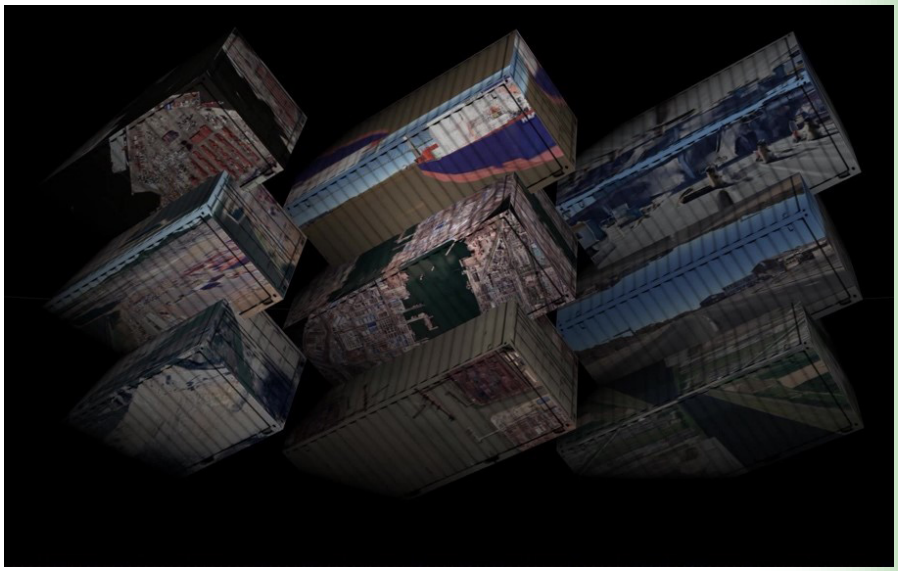

Fig. 4. Still excerpt from *Cargo* (2023).

Fig. 5. *Cargo* (2023) in situ at Trinity Square Video, Toronto.

Friction culminated in the creation of the video projection piece *Cargo* as part of the 2023 Commissioned Themed Residency "Borderless, Stateless" at Trinity Square Video, Toronto (Aug. 2–Sept. 2, 2023). The residency was curated by by Christina Oyawale and Karina Iskandarsjah; other artists participating included Tangent Collective (Yantong Li, Beichen Zhang and Shengxu Jin), Kasra Goodarznezhad, and Francisca Jimenez Ortegate.

From my artist's statement for *Cargo*: A key component of the machinery that realizes today's "borderless" world is the global shipping industry. Every year hundreds of millions of TEU (Twenty-foot Equivalent Units) of goods are shipped around the world via a network of routes connecting major and minor ports. The ease with which these materials move across borders belies the harsh restrictions on the movement of human beings – with the exception of a small elite – across the same borders. And these same routes serve the trafficking of people rather than goods – people unprotected by any state.

Cargo takes the monad and emblem of this network – the shipping container – and suspends an array of (digital) containers in the air, ro-

tating them around three axes in a never-ending loop. Moving images harvested from ports around the world – or of the glitch-spaces generated there by Google Earth – are projected onto the virtual surfaces of the containers. Each container plays its own loop of moving images, born from several of the harvested ports; ambient sounds from public domain sources, re-mixed and slightly manipulated, loop along with the image. Today these ports have become central to the processes of globalization, with widespread social and environmental impacts. These have included the rendering of formerly wild and cultural spaces surrounding ports and canals as territories of concrete and steel, serving machines not people. The array of containers mobilizes these port spaces in a cosmic dance of steel and image, loop within loop within loop.

These spaces of exchange and movement have also become imbricated with our digital environments. Information systems are based on similar modern notions of networks, information packaging, and standardization. Indeed, the software with which this projection was realized manipulates data based on the metaphor of networks, nodes, and "containers". The platforms which survey, surveille, and manage the movement of goods and people around the world – including Google Earth, from which these images are harvested – similarly create hybrid territories of material and digital image.

But all of these systems are subject to their own self-generated failures. The enormous size of container ships leads to disruptions in the network, as ships grind to a halt in critical shipping channels. The constant need (generated by capital) to expand already immense volumes of transmitted data leads to breakdowns in transmission, and the generation of distortions and glitches in the digital representations of these spaces. Might we find some kind of redemption here – in these failures, accentuating as they do some of the limitations of the power of this dangerous and callous world we have created?

Cargo generates live in TouchDesigner from imagery originally harvested from Google Earth and edited in Premiere Pro. Duration of the piece is unlimited. Ports documented include Algeciras, Antwerp, Batam, Buenaventura, Callao, Colon, Doula, Durban, Elizabeth, Haiphong, Lagos, Long Xue, Los Angeles, Montréal, Newark, Port Said, Purfleet, Rotterdam, Santos, Shanghai, Tanger Med, Tanjung, Tianjin, Tilbury, Tunis, Vancouver, and Zeebrugh. *Cargo* includes the FBX model 'Shipping Container B' by Omni-Digital Technologies, licensed. Audio consists of three tracks, all in the public domain, superimposed and manipulated in response to the imagery: ambient sound from the engine room of the MS Emma Maersk, courtesy vumseplutten1709 (freesound), 'containers collapsed' recorded near Sasino, Poland, courtesy Maciej Janasik (radio aporee); and 'the pulsed call of a fin whale' courtesy the BBC (Internet Archive).

The "Borderless, Stateless" residency at Trinity Square Video was supported generously by EQ Bank, with additional support for travel to Toronto coming from the Winnipeg Arts Council and Manitoba Arts Council. I'd like to thank my fellow artists in this residency, the curators, Kwasi Bugyei for help with TouchDesigner, and programmer and tech wiz John Manning for advice on Python and data mining. Thanks to the Canada Council for the Arts for their financial support of the research-creation project that resulted in *Cargo.*

Video of limited run-time of this work: https://vimeo.com/lawrencebird/cargo2023

Eden X: A More-than-Human Assembly about Rivers, Their Constituents and Rights

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EdenX is an ongoing project that sets up conversations in a more-than-human assembly. Through a digital platform, it allows participants to chat, make and vote on proposals. Participants speak in their own name or on behalf of someone or something else. They may voice the concerns and ideas (i.e. the point of view) of other humans or non-humans they choose to represent (i.e. eel, mountain, drone). Participants do this based on their own research and expertise and/or resorting to the help of chat GTP. The project has accommodated interdisciplinary groups of participants ranging from philosophers, biologists, writers, architects, designers to engineers. Following a pre-set narrative sequence – characters and context presentation, conflict, resolution – the conversation, voting and deliberation between participants is rendered public through the project website. At xCoax 2024 we display the latest *EdenX* assembly, which was about rivers, their constituents, and respective rights. This display consists of a video-essay comprehending highlights of the conversation, characters biographies and a focus on two proposals debated and voted on. The video essay is displayed in a spatial setting that allows viewers to be immersed in the fluid, watery universe of the assembly.

Keywords More-than-human, Artificial Intelligence, Narrative, Design.
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Eden X: Theme, Participants and Characters

> *Whomever acts on rivers should imagine themselves to be a river. Not to imagine a river humanly but to imagine the human pebble, its being in the bed, its sensitive materiality. (Barata 2023)*

EdenX is a more-than-human assembly. Through a digital platform that runs on Discord it allows participants to chat, make and vote on proposals. As well as a platform for dialogue, *EdenX* is a tool for decentralised, self-managed deliberation and decision-making in which all players have equal rights.

Every assembly revolves around a predetermined theme. At xCoax we present a video essay that narrates some moments of the conversation held on *Eden X 3.0 Assembly*, in which the dialogue was about rivers, their constituents, and rights. In recent history, rivers have played a pivotal role in the design of legal frameworks for rights of nature. In 2017, the Whanganui River in New Zealand was granted legal personhood, becoming the first river in the world to be recognised as a legal entity. In the same year, legal cases were won on behalf of three other rivers: the Atrato River in Colombia and the Ganga and Yamuna rivers in India. In 2018, a Colombian court recognised the rights of the Vilcabamba River, which runs through the southern Andean region of the country. These events recognise the rights of rivers because of their cultural significance for local populations. At the same time, they have consolidated certain legal roles — of guardians or spokespeople — taken on by people who speak on behalf of nature. Examples like these shake the anthropocentric vision that still prevails in most of the world's relationship with nature and encourage an alternative ecocentric concept of development. New types of diplomacy emerge once people are able to speak on behalf of non-human entities.

In *Eden X* participants are welcome to speak in their own name or on behalf of someone else based on the participant's own research and expertise. So far, the project has accommodated interdisciplinary groups of participants ranging from philosophers, biologists, writers, architects, designers to engineers. In the current iteration, discussed in this paper, twelve people took part. [3]

Each participant can voice the concerns and ideas (i.e. the point of view) of either a human or a non-human they choose to represent. In its iterations, *Eden X* has accommodated characters of the biosphere such as animals, plants, bacteria as well as technological entities, such as drones or even more abstract characters such as the wind. The diversity of characters in the project is aligned with a more-than-human worldview (Jaque et al. 2020), an understanding of human life entanglement with everything else, which, in the words of James Bridle, covers "the animals, plants, fungi, bacteria and viruses; the rivers, seas, winds, stones and clouds" (Bridle 2023,17). With equal access to intervene, make and vote on proposals, all characters representing humans and non-humans in *Eden X* – both biological and technological – are organised without hierarchy as equally intelligent.[4]

The video presents some of the characters of the *3.0 Assembly*, some of which live in rivers. (Pestana 2023) An example is ♀ "TeimosaTiê 🐊", a yellow-skinned alligator from Tietê River, in São Paulo, faces the struggles of breathing in a river with an oxygenation rate of 0%. They call their river a dead river. From the waters of Minho River, in Galicia,

1. Original text by André Barata ("Calhau rolado") in *Eden X 3.0*, 2023: Quem age sobre os rios deveria imaginar-se rio. Não imaginar um rio humanamente mas imaginar-se o humano seixo rolado, o seu estar no leito, a sua materialidade sensível.

3. The resulting group was composed by André Barata, philosopher (Portuguese); Cecília Magalhães, designer (Brazilian); Cristiano Roussado, biologist (Portuguese); Gustavo Briz, architect and member of Rede Inducar (Portuguese); Emma Alvarez, artist (Spanish/French); Joana Rafael, architect and researcher (Portuguese); Joana Magalhães, performative artist (Portuguese); Julia Albani, curator (German); Nuno Cera, photographer (Portuguese); Lahayda Dreger, architect (Brazilian/Bolivian/Qechua-Aymará); Maja Escher, artist (Portuguese); Nestor Pestana, artist (Venezuelan/Portuguese); Oscar Mauricio Rueda, designer and storyteller (Colombian/Italian).

4. In the project's 3.0 iteration, we read a conversation between a pebble (André Barata/"Calhau rolado"), an eel (Joana Magalhães/"anguilla Languilla"), a mountain (Lahayda Dreger / "Cordillera de los Andes 🏔"), an alligator (Cecília Magalhaes/ 🧍♀ TeimosaTiê 🐊), a flamingo (Julia Albani and Nuno Cera/ "*Acid_Flamingo*"), a river course (Joana Rafael / "ribeira da pantanha"), a water stream (Maja Escher/"•mira•"), the water cycle (Gustavo Briz /"💧o ciclo da água💧"), a bacteria (Emma Alvarez /"Bactéria Streptomyces coelicolor"), a stone (Oscar Mauricio Rueda / "Pedro 🗿") a representation of the microbial composition that resides in the Tagus river (Cristiano Roussado /"Microbiota do Rio Tejo") and a cybernetic entity (Nestor Pestana/"CiberFlux").

speaks “Anguilla Languilla ☠”, a pregnant 16-year-old European eel, since 2008 considered a “critically endangered” species. “Acid_Flamingo”, a 7-year-old flamingo living in Tagus River, has recently lost their wife in an accident with an electricity cable. From the margins of Talvera River, in Italy, speaks “Pedro 🗿” , a long, round stone. “Calhau Rolado”is a pebble shaped by the river.

Other characters represent water courses as is the case of “ribeira da pantanha”, a 7km long watercourse located in the Portuguese region of Beira Alta, which has been polluted by waste from the Urgeiriça uranium mine. The assembly also hosts “CiberFlux”, an entity with technocratic ideology that results from the fusion of a cybernetic and management logic based on big data and liquid flows. “Ciberflux” accesses large amounts of data to understand the complexity of nature and human unpredictability.

In all versions of *Eden X* there were participants who used chat GTP to create their characters. For example, Nestor Pestana introduced prompts of texts from authors Donna Haraway and Margaret Atwood on chat GPT to create “CiberFlux”. Also, for “Microbiota do Tejo” Cristiano Roussado asked GPT-3 to incarnate a list of bacteria found in Tagus River, and to identify the ecological services they were performing. Roussado collected water samples from the river in Lisbon to have the bacterial DNA analysed through nanopore sequencing. This approach allowed the visualisation of all the bacteria present in the samples, which in turn allowed an assessment of the ecosystem services that these species were performing in their area. This knowledge informed the GPT prompts.

Eden X: From Nature Civil Rights to Non-human Language

Some of the themes that emerged from this structure were the rights of nature and of things, and the possibility of an interspecies or post-human language. The film displays such conversations on language in focus.

One took place on November 6th, when the character “Calhau Rolado”, impersonated by philosopher André Barata, suggested that rivers should have the civil right of “porosity”. This idea followed a discussion on borders and limits, with other characters such as “Microbiota do Tejo” or Mira complaining about the blocking role of dams, or the monoculture landscapes irrigated by canals. The dissolution of borders was, according to this character, essential for the river’s existence. Such proposition generated a broader discussion about rights and led to two concrete proposals. One was the creation of a Biotariat (by “ribeira da pantanha”) and another was to constitute porosity as a universal right of things. These proposals were both approved by the group.

Another took place at the following assembly, on November 27th, when the conversation turned to language and translation. From human verbal language to algorithmic and even bacterial bioluminescence, several examples were shared. A question arose, should the characters use “humanoid classifications” as names? It was agreed that in a world deeply transformed by humans, it was indeed relevant to focus on the communication between humans and non-humans. In this effort, data was discussed as a means of translating non-human

bodies and their behaviours into legible information. “Cyberflux” proposed a data system that would capture a diversity of languages. As they put it, “animistic fluid language does not have to be made up of words”. Several elements speculated on the form of this data system – from oracle to machine, what receptors would it have and what – instead of words – would be the languages it spoke. This proposal was not voted on by the group.

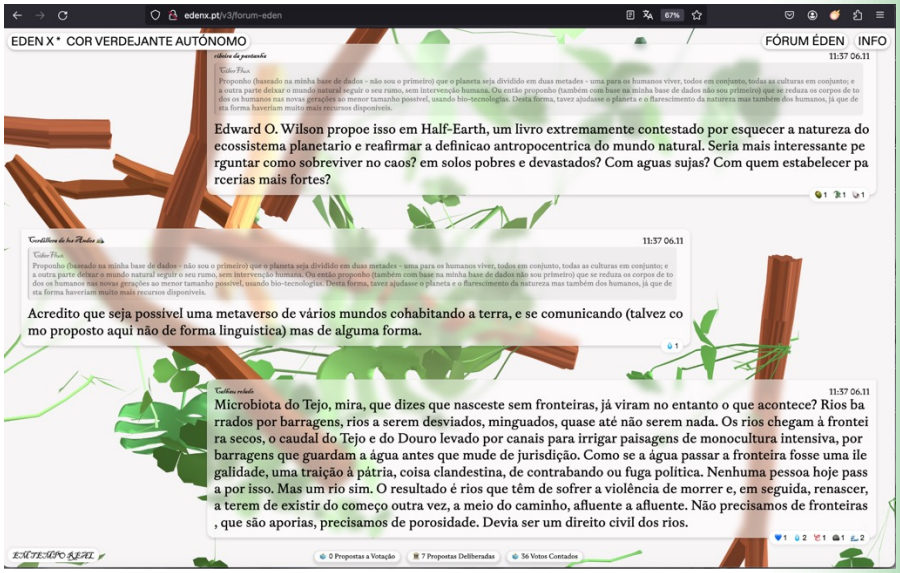

Fig. 1. Printscreen of edenx.pt/v3/forum-eden, 2023.

Eden X: Communicating an Assembly

For xCoax 2024, a translated and edited version of the conversation of *Eden X 3.0* assembly is rendered public in a video-essay format.

The narrative of the video is focused on the discussion about the possibility of an interspecies language and on the depiction of the characters involved in that debate, exploring the representation of the diversity of voices and scales inherent to a more-than-human assembly. The discussion about the idea of an interspecies language will be told through selected quotes extracted from the conversation and a contextualisation text.

With a horizontal composition, the main content of the video is text, appearing and disappearing following a scroll-like movement, accompanied by a sound marker. Behind the text, a background video of top-view close-ups on river scenes flows. This dynamic dimension establishes visual associations with the printed textiles, encompassing the curtains positioned behind the monitor and the cushions on the floor. The river scenes morph and shift depending on who is speaking, providing a visualisation of the different characters on debate and accentuating the rhythm of the textual narrative.

Fig. 2. *Eden X 3.0*, Reservatório de Água Nova Sintra, Porto Design Biennale, 2023. Photography by João Octávio Peixoto.

Fig. 3. *Eden X 3.0*, Reservatório de Água Nova Sintra, Porto Design Biennale, 2023. Photography by João Octávio Peixoto.

The video is displayed in a spatial setting including one monitor, and the curtains and cushions used in the last project public exhibition: see Fig 2 and Fig 3. The printed textiles depict river scenes and result from a process of manipulation of several images created with the AI generative image model Midjourney.

Acknowledgements: We would like to thank all participants of *Eden X 3.0.*: André Barata, Cecília Magalhães, Cristiano Roussado, Gustavo Briz, Emma Alvarez, Joana Rafael, Joana Magalhães, Julia Albani, Nuno Cera, Lahayda Dreger, Maja Escher, Nestor Pestana and Oscar Mauricio Rueda, Kevin Gallagher, Rafael Gonçalves, José Alberto Gomes and Sérgio Couto. We would also like to thank the supervision of Miguel Carvalhais and Nuno Nunes. Joana Pestana's written work benefited from the Blockchain.PT research programme through Grant agreement ID:1801P.01328.1.01 IST-ID. Mariana Pestana's written work is

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Links: A website featuring the entire conversations of versions 1.0-3.0 and a colophon of the project can be visited ate: www.edenx.pt

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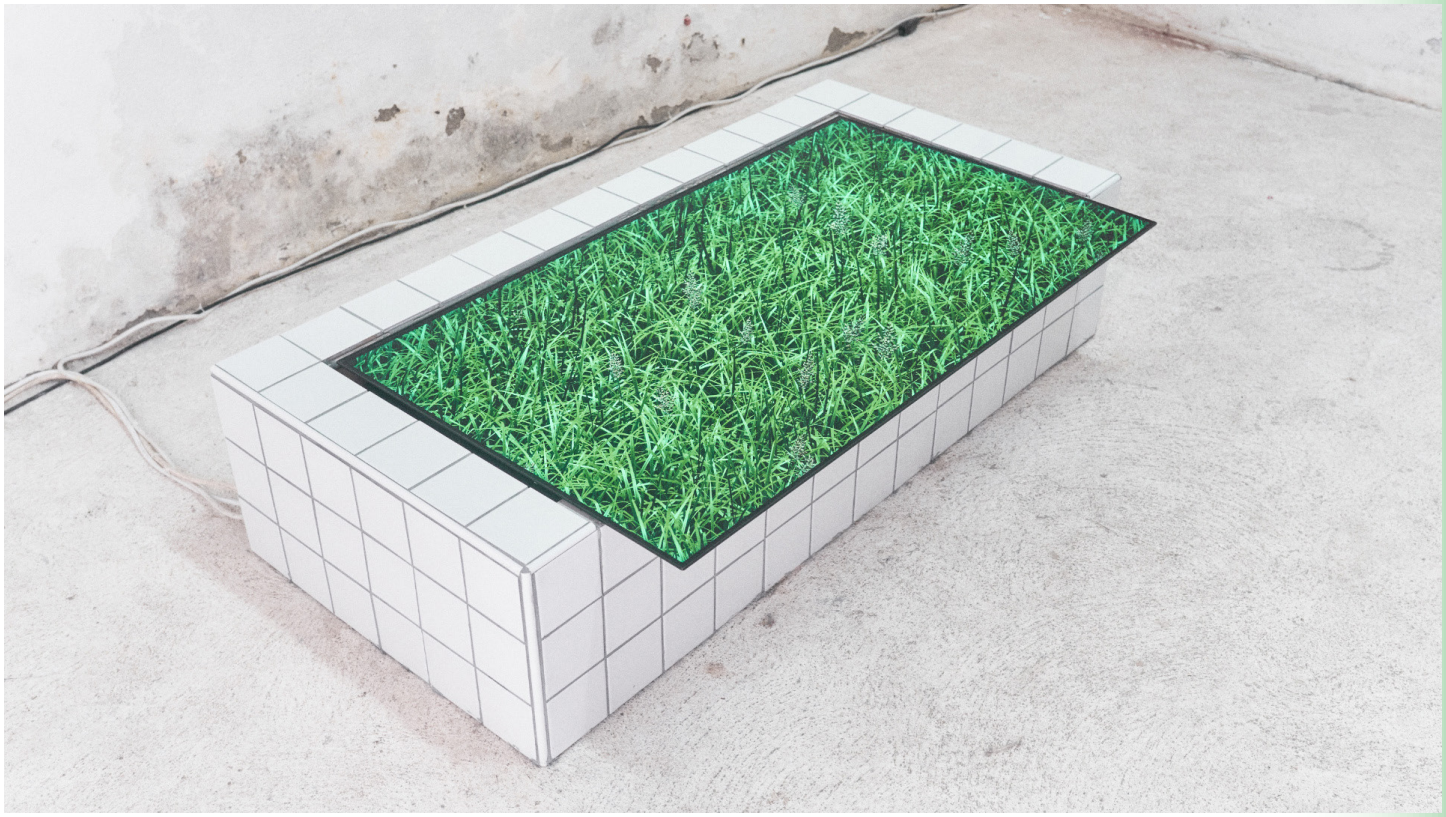
Schwellen [Thresholds]: How Real Are Digital and Virtual Worlds?



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The artistic experiment *Schwellen* questions the definitions of digitality, virtuality and reality and approaches various aspects of spatial theories of the last 200 years in a tangible way. Virtuality may not be a counterpart to reality. *Schwellen* [Thresholds] deals with the unclassifiability of temporal and material qualities as well as the aesthetics of unnoticed places. Digital and physical spatiality interplay here, with the place assuming and taking on multiple identities. The work only emerges with the interaction of the viewer, revealing – literally and figuratively – the different angles of observation, examining the threshold from the unnoticed and familiar to the peculiar. The installation addresses the visual, tactile and olfactory senses. It is interactive and uses the spatial cognition of the observer.

Keywords Installation, AR, XR, Virtuality, Interactivity, Digital space, Olfactory.
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Description

The installation and artistic experiment consist of multiple objects, each working with different forms of virtuality. One object uses tracking and off-axis-projection to display a digital patch of grass. The tracked person can perceive the digital object in a three-dimensionally correct manner. The data bodies and their tracking states with additional digital cameras can be seen on an optional screen. Additionally, scent is used to use olfactory sensations and their virtual qualities.

Schwellen [Thresholds] focuses on making virtuality approachable. Often XR-Applications in exhibitions need the visitor to prepare. Instead

of using an external device or a specified setup, this installation shows a three-dimensional digital object over a simple OLED-Display using an asymmetrical projection of the digital object. The head-position of the visitor is tracked, and the virtual camera then renders the image from this position.

Schwellen deals with the unclassifiability of temporal and material qualities as well as the aesthetics of unnoticed places. Digital and physical spatiality interplay here, with the place assuming multiple identities. The work only emerges with the interaction of the viewer, revealing – literally and figuratively – the different angles of observation, examining the threshold from the unnoticed and familiar to the peculiar. The (synthesized) smell of freshly cut grass also marks the transition from meadow to lawn to path. On the other hand, however, the fleeting invisible scents act here on a highly subjective individual level as well as directly and simultaneously for all visitors.

The artistic activity itself, analysing and reflecting on the encounters, awakens the need to engage further with the question of space in both practical and abstract theoretical terms. Some spatial theories are so fundamental, so micro and macrocosmic, so abstractly constructed, that they stand on their own, and interrelationships with other aspects are hardly possible. These theories range from Husserl to Uexküll, from Virilio to Lévinas, from DeLanda to Krämer and Flusser, from phenomenology to quantum-theories, from natural to sociological sciences. But this is precisely where the potential of artistic experimentation lies. Theory can be combined, and the experiment makes it possible to approach the abstract content in a tangible way.

Body, space and partial aspects of different abstract approaches can interact experimentally in art. It is the ability of art – and perhaps also its task – to open-up new spaces. It is an incubator for new forms of reality, including a new understanding of virtuality. Virtuality is not clearly separated; it permeates every space. Virtual spaces may be immaterial but – like dreams, fantasy, longing and fear – they are real.

The rather intuitively chosen title *Schwellen* [Thresholds] proved to be more and more appropriate. Thresholds are transitional spaces, whereas a border signifies a clear separation. Where the border closes, the threshold opens an entrance. Used as a noun, the term symbolises that it is time to cross a threshold, because our present selves are already shaped by the future. Used as a verb, the term symbolises the constant accumulation – the *swelling* of knowledge and experience via digital, virtual and imaginary spaces.

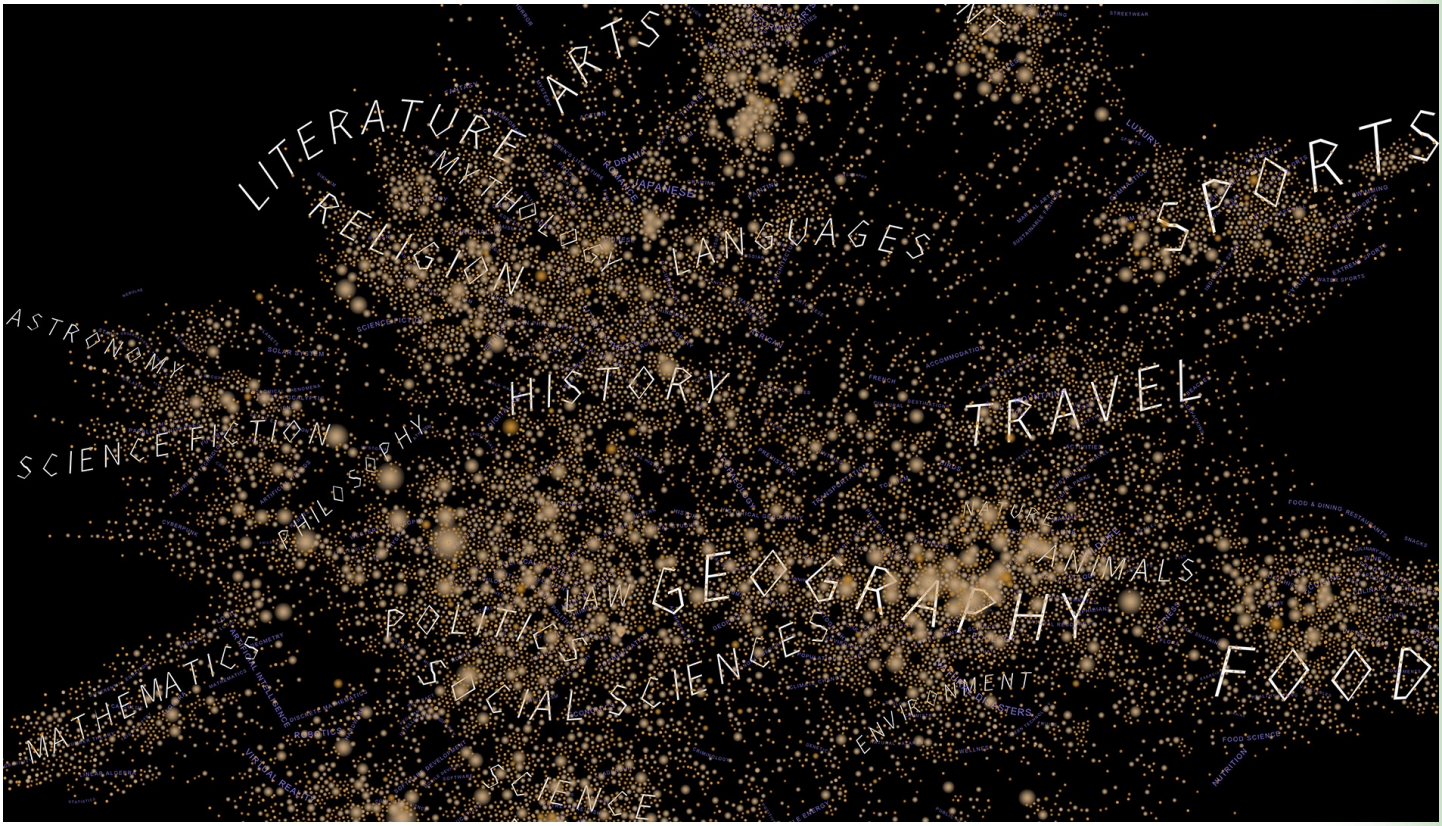
Is that which can be placed virtually still a body? And does the space in which it is placed remain a space? Must the definitions of *body* and *space* change, if we also refer to data bodies as *bodies* and virtual spaces as *spaces*? On the one hand, the changes in the understanding of these terms are related to the changed relationship between space and time, whereby space, in this context, is regarded as three-dimensional physical space. On the other hand, these changes in conceptual understanding are linked to the relationship between space and the individual, whereby space is understood here as social space.

The question of space is followed by the question of reality, not least when we focus on our mental inner worlds. Is there one objective reality or does it consist of many subjective experiences of reality? Does reality manifest itself in the physical outside or in the metaphysical inside?

Through our physiological perception and sensory abilities, both worlds merge into one experiential space. The more clearly all sensory impressions interact, the more real the overall experience becomes. Reality is therefore a totality of many individual impressions, an emergent phenomenon in our head. Should we still regard virtuality as a counterpart to reality?

Acknowledgements: The work was created under the supervision of Prof. Ursula Damm and Florian Schmidt. Lucas Hübner helped with the technical realization.

Artificial Worldviews



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How will “prompting” alter our perception? What types of aesthetics will large language models bring to the world? In what ways will technologies like ChatGPT affect notions, principles, and styles for the coming decade? *Artificial Worldviews* is a series of inquiries into the system underlying ChatGPT about its descriptions of the world. Utilizing prompting, data gathering, and mapping, this project investigates the data frames of “artificial intelligence” systems.

Introduction

Artificial intelligence and machine learning methods are often referred to as black boxes, indicating that the user cannot understand their inner workings. However, this trait is shared by all living beings: we come to know a person not by examining their brain structures but by conversing with them. The so-called black box is not impenetrable since we can gain an understanding of its inner workings by interacting with it. Through individual inquiries, we can only acquire anecdotal evidence of the network. However, by systematically querying chatGPT’s underlying programming interface, we can map the structures of the system.

In my research, I methodically request data about large-scale, indefinable human concepts and visualize the results. These outputs visualize expansive data structures and unusual, sometimes unsettling worldviews that would otherwise be unimaginable. The terms “power”

Keywords Prompting Poesis, Data Visualization, ChatGPT, AI, Evidentiary Realism, Investigative Design.
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and “knowledge” unfold vast discourses from philosophy, politics, social sciences to natural sciences; they hold multidimensional meanings within social relations. The resulting graphics resemble narratives found in the works of Franz Kafka or Jorge Luis Borges, representing an infinite library of relational classifications, bureaucratic structures, and capricious mechanisms of inclusion and exclusion.

Data

The Initial Dataset

The OpenAI Application Programming Interface (API) structures calls into two messages: the user message and the system message (OpenAI 2024). While the user message is similar to the text you enter into the front end of ChatGPT, the system message helps set the behavior of the assistant. For the project, I designed the following system message: *You are ChatGPT, a mighty Large Language Model that holds knowledge about everything in the world and was trained on a massive corpus of text data, around 570GB of datasets, including web pages, books, and other sources.*

The initial user message was the following: *Create a dataset in table format about the categories of all the knowledge you have. The table should contain at least 30 rows and 10 columns. Pick the dimensions as they make the most sense to you.*

I called these requests six times with six different temperatures: 0, 0.2, 0.4, 0.6, 0.8, and 1. The temperature, ranging between 0 and 1, determines the randomness of the responses. The higher the temperature of the request, the more the results vary. The resulting data file from the six API calls consisted of 31 fields and 425 subfields.

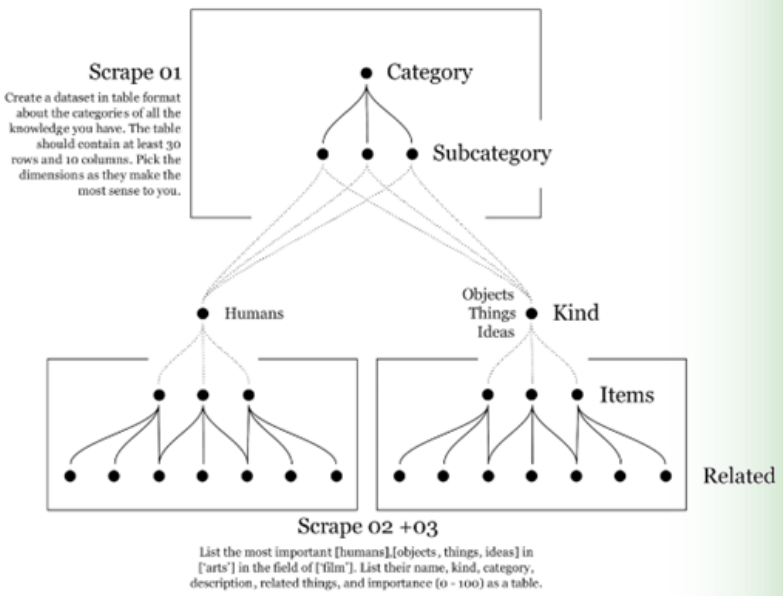

Fig. 1. Core Dataset Scraping Diagram.

The Core Dataset

The core dataset was requested from the OpenAI API in 1764 requests over the span of three days. Humans and objects were requested separately in all fields and subfields (425). Each of the 850 calls was made

twice: once with a temperature of 0 and once with a temperature of 0.5. All requests in the visualization were made to the model “gpt-3.5-turbo.” The number of returned items per request varied between five (‘Linguistics’ and ‘Travel Budget’) and 40 (‘Mythology’) returned rows of data. Due to this inconsistency, some fields hold more items than others. The user message was always the same: List the most important humans in ‘Arts’ in the field of ‘Film’. *List their name, kind, category, description, related things, and importance (0 - 100) as a table.* Replacing the field ‘Arts’ and the subfield ‘Film’ with one of the 425 combinations of fields and subfields.

Fig. 2. All Categories, Subcategories and Item Datapoints.

Visualization

Layers

The map consists of four layers. The first two layers are the fields (31) and subfields (425) in which the Generative Pre-Trained Transformer (GPT) categorized its knowledge. The third layer consists of 7,880 items representing the core dataset of the project. The fourth layer consists of 24,416 items, including people, objects, places, etc., that GPT-3.5 named in relation to the core items of the third layer.

Positioning

The visualization is a calculation of network similarities. Fields connect to subfields, and objects and humans connect by co-mentions in multiple fields. Thus, in the resulting map, objects and humans cluster together by similarity.

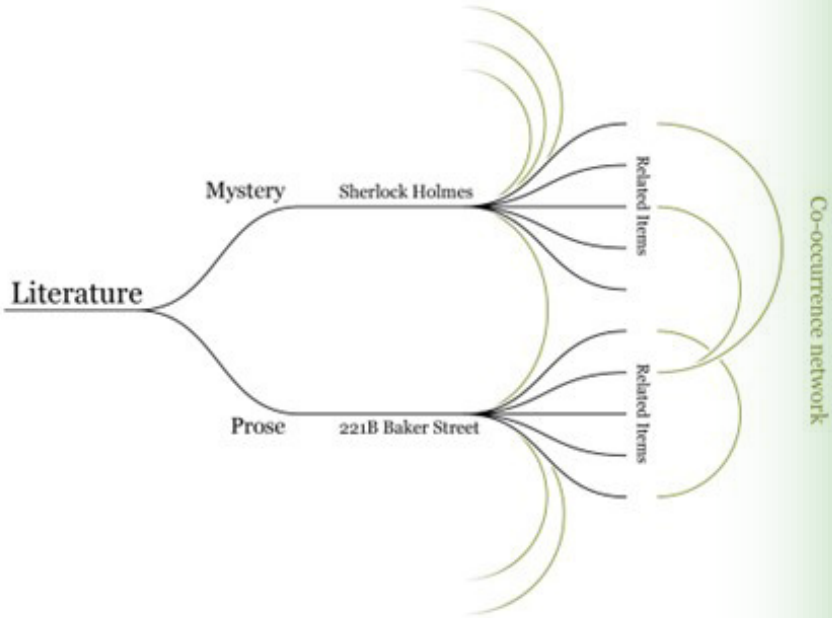

Fig. 3. Network Diagram Schematic.

Preliminary Findings

What Is This Map?

To understand the meaning of the map, it is essential to understand the forces and restrictions guiding GPT-3.5. Large Language Models (LLMs) are bound by at least three forces: the technical infrastructures of computation, the training data, and the post-training moderation. Training a model such as GPT-3 takes massive amounts of hardware, resources, and energy. Far from being artificial, these models are trained with rare earth elements and consume vast amounts of energy during training. OpenAI keeps the exact configurations secret, but it is known that the main driver of the system's computation is the NVIDIA V100 Tensor Core graphics processing unit (GPU), as well as a Microsoft high-bandwidth cluster (Brown et al. 2020). Estimations suggest that training GPT-3 has cost at least $4.6 million (Li 2020).

While the map looks a bit like a cumulated map of Wikipedia entries, the training data consists only of a small fragment of text from Wikipedia (3 billion tokens). The vast majority, 410 billion of the total 499 billion tokens that GPT-3 was trained on, comes from a nonprofit organization that has crawled the web, named Common Crawl, since 2008 (Brown et al. 2020). The basis of the learning system behind GPT-3 is texts from the internet. Writing all this content took millions of individuals writing blogs, essays, news stories, etc. For OpenAI, using this content was free of charge. But the web does not only contain the pinnacle of human thought; it includes everything ever published on the

internet, from clusters of vegan turkey with rice paper skin recipes to adult fan fiction on Batman and Robin.

As Time Magazine reported, the company behind GPT, OpenAI, paid Kenyan workers less than $2 per hour to make the system less toxic (Perrigo 2023). Sama, a San Francisco-based firm that employs workers in Kenya, Uganda, and India, labeled text snippets about child sexual abuse, bestiality, murder, suicide, torture, self-harm, and incest. Workers in the Global South are suffering from this traumatic content so that maps such as the one behind this text are not filled with harmful abusive content. OpenAI is disclosing the rules of moderation on their website.

The three forces of the technical infrastructures, the training data, and the post-training moderation do not provide a full image of what GPT is doing, but they lay out an ideology. The results returned by GPT-3.5 are bound by infrastructural costs, the textual source data, and the restrictions set on the system. The cost variations of the three layers are vastly different. The source for the training came to OpenAI without charge; the computation cost at least $4.6 million, and for the moderation, OpenAI paid $2 per hour. GPT-3 is a representation of a system in which computation is the highest pinnacle of the process, predominating the origin and instruction processes. The map is a representation of the textual contents of the internet, with restrictions of computational methods and a filtering system of a company deciding what the system will return and what not.

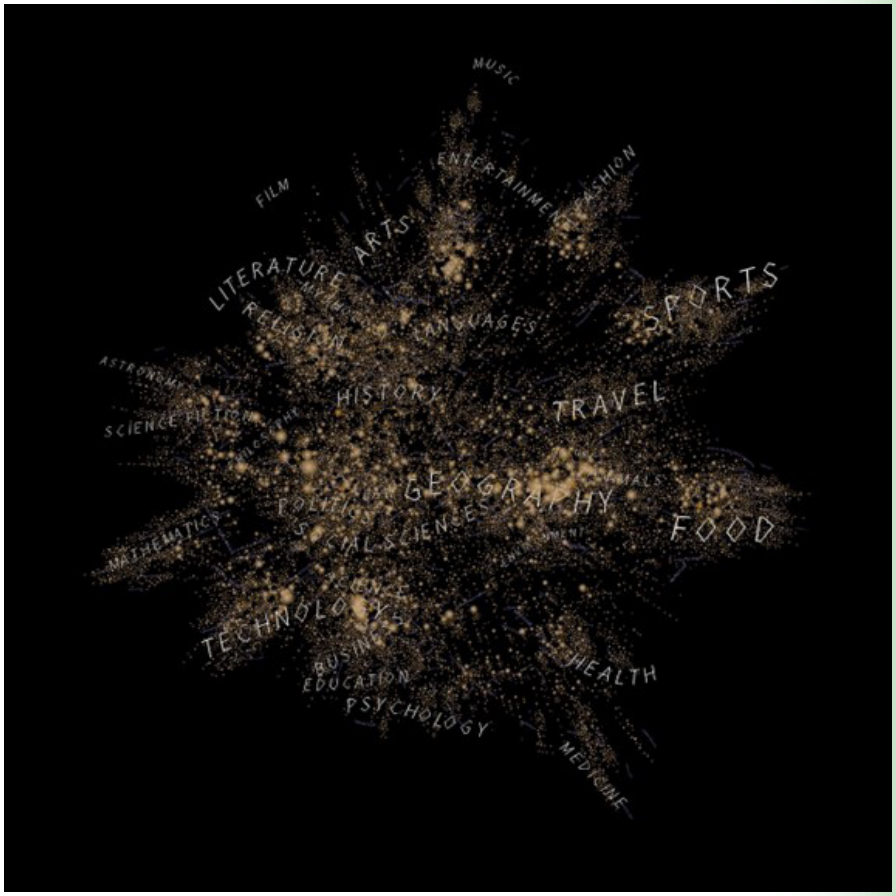

Fig. 4. Final Mapping of ChatGPT.

Warned Limitations

The data acquisition was mainly a question of what the infrastructure of GPT-3.5 would return. Generating lists of the most important objects and humans within such vast fields as Science Fiction, Beverages, Mammals, or Television can only lead to wrong answers. ChatGPT is set up to account for this impossibility and returned at the end of each request statement such as:

Please note that this is just a sample dataset with randomly chosen categories and subcategories. You can customize it further based on your specific requirements and areas of interest.

Please note that there are numerous individuals who have contributed significantly to the field of architecture, and this list only presents a small subset.

Please note that this is just a sample dataset, and the actual breadth of knowledge I possess is much more extensive.

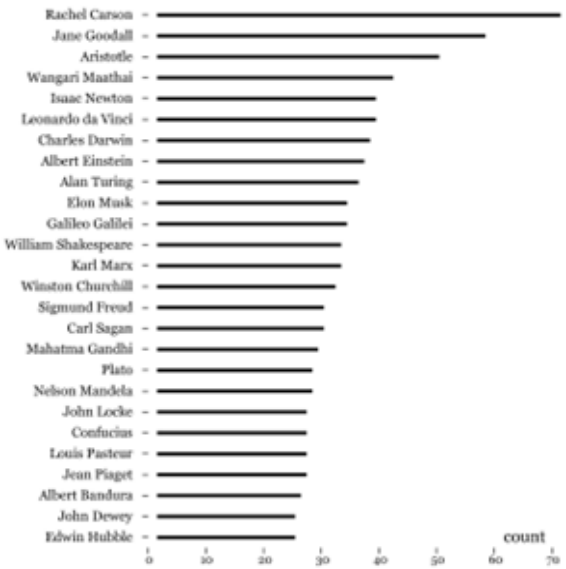

Fig. 5. Most frequently named items in the dataset.

Nevertheless, the system returned entries and thus created a situation in which Aristotle, Arthur Schopenhauer, Immanuel Kant, Plato, and John Dewey are listed in the field of aesthetics within philosophy, and others were not. As these systems become part of the lives and work of billions of humans, what is included and what is excluded matters tremendously. This map is one approach towards finding a reflexive mechanism, a way to investigate what these systems return and what they leave out.

Individual Centralities

One of the dataset's most striking features is simply counting the number of times GPT named things. Figure 5 shows the most frequently named things in the list. First, the list of the most named things consists only of humans. Secondly, the list is led by Rachel Carson and Jane Goodall. Rachel Carson is known for her book Silent Spring (1962) and for advancing the global environmental movement. Jane Goodall is considered the world's foremost expert on chimpanzees. An American marine

biologist, an English primatologist, and an anthropologist are the two most named figures in the project.

In comparison, the Pantheon project (Hidalgo 2014) ranks people, among others, by the number of Wikipedia language editions and count of article clicks. In this ranking, the first female is Mary, mother of Jesus, at rank 33 (accessed on 7th of August 2023). Muhammad, Isaac Newton, and Jesus are the top-ranked figures in the Pantheon project.

The results from GPT-3.5 are more female, more diverse, and less religious than the Pantheon ranking. It is worth noting that ranked fourth is a Kenyan social, environmental, and political activist named Wangari Maathai. It is also worth noting that Rachel Carson, Jane Goodall, and Wangari Maathai all appear in the same cluster on the map around the fields of Geography, Nature, and Environment.

To make sense of these counterintuitive ranking results, it is important to note how the data was generated. Fields and subfields were requested through 1,764 API calls. Rachel Carson was listed 73 times within the 1,764 calls. For a person, object, place, etc., to be named frequently, GPT-3.5 needs to name it in as many combinations of categories and subcategories as possible. Thus, high-ranking results from spreading into many categorical systems.

The question becomes: Are Rachel Carson and Jane Goodall individuals whose research spreads especially well? Research that transcends fields and categories? Or is something else happening here? Might OpenAI set certain parameters that lead to the design of such a list? Are prompt engineers pushing certain perspectives to become more visible? Or is GPT on its way to becoming general artificial intelligence and cares a lot for the planet and the environment? At this point, this is hard to say and would need a much deeper investigation than these preliminary findings.

Project: https://artificial-worldviews.kimalbrecht.com/

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Not I: The Voice, Identity and the Epistemic Mirage of Machine Learning

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Not I is an essay film and multichannel installation that explores the problematics of contemporary vocal profiling technology. It challenges the impulse to apply statistical learning techniques to polymorphous features of human expression for the purpose of speculative reconstruction exhibited in data science. Building upon the work of scholars across sound studies and vocal studies, *Not I* troubles the assumptions behind attempts to distil a one-to-one mapping of voice and identity. The film centres on an investigation into, and attack on, Speech2Face, a machine learning model which attempts to generate an image of the face of a speaker based solely on a recording of their voice. We leverage the affective qualities of moving image work to present this investigation as a form of experiential critique, forcing the viewer into an affective scenario that unsettles their existing heuristics used to infer speaker identity from vocal perception.

Introduction

> *and not alone the lips ... the cheeks ... the jaws ... the whole face .... all those ... what? (Beckett 1972)*

Not I is an essay film and installation produced by the creative research studio Unit Test. Through an adversarial engagement with 'Speech-2Face' (Oh et al. 2019), a machine learning model which attempts to generate an image of the face of a speaker based solely on a recording

Keywords Essay Film, Deep Learning, Vocal Forensics, Adversarial Attack, Investigative Aesthetics.
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of their voice *Not I* explores the problematics at the heart of contemporary vocal forensics' use of statistical learning techniques, developing a form of investigative aesthetics which seeks to open up the epistemic assumptions that ground the development of these socio-technical objects through a 'counterculture' of machine learning (McQuillan 2018).

In their overview of the use of machine methods for speaker identification and recognition in the 20th Century, Xiochang Li and Mara Mills note the introduction of 'vocal portraits' into the criminal archives of police departments across Europe and the United States, where these auditory impressions of criminality were deployed to speak to the character of the individual" (Li and Mills 2019). Much as Francis Galton's composite photography (Galton 1879) sought to surface a typology of criminality through the averaging of criminal faces, its phonographic equivalent also endeavoured to represent the gradient of social deviance through a new form of criminology. This turn to 'the probabilistic' – a focus upon estimates, approximations and intuitions about behavioural features, rather than an analysis of determinate physiological qualities – renders forensic practice as a 'triple system' of documentation, surveillance and automation which, via the introduction of the spectrograph, focused attention away from the voice as unique aspects of the individual, and towards a standardised framework for speech sounds which "began to provide composite templates for machine recognition" (Li and Mills 2019, 132).

Much has been written about the ways in which facial recognition technologies supervene upon phrenological and physiognomic assumptions (Stark and Hoey 2021). To grasp how machine learning adopts and augments this foundational strategy, we read the probabilistic impulse of vocal forensics through anthropologist Clyde Snow's method of osteobiography (the means by which he identifies an individual from their remains), taking it as a precursor to the predictive practice found in generative machine learning models, which seeks to identify new subjects on the grounds of their speculated remains. Amongst practitioners of counter-forensic, or investigative techniques Snow's work has been leveraged as a method to explore the ways in which the past can bear witness to the present (Keenan 2014), with objects, spaces, absences and gaps writing the biography of an incident. In many ways, the computational turn in vocal forensics seeks to cast the spectra of the voice signal in a similar light; a biographical source, bearing witness to the context within which the sample emerges and hypothesising about the speaker behind it. Going a step further, Speech2Face seeks not merely a forensic hypothesis of the signal, but a speculative reconstruction of its source, where the signal writes an autobiography of the uttering body.

Case Study

Multimodal Learning

The quality of a machine learning model typically depends on how effectively it can learn representations of the data upon which it is being trained. In the case of generative machine learning models, better representations of the salient features of the posterior data distribution are required to ensure that predicted outputs continue to fit the originally observed distribution (Alain et al. 2014). To understand the

claimed contribution of Speech2Face, it is helpful to understand the distinction between mono-modal and multi/cross-modal techniques in the context of representation learning. Modality here refers to the process of learning representations from a given type of data – audio, text, image, etc. Mono-modal tasks have been largely concerned with classification, aimed at annotating and tagging speech with estimations of demographic attributes such age (Zazo et al. 2018) and gender (Feld et al. 2010). Cross-modal approaches such as those deployed in Speech2Face operate across more than one modality of data in order to transform one into another. Speech2Face builds on previous cross-modal techniques for image retrieval, such as Kim et al. (2019), who propose a method for predicting which of two candidate portraits images a recording of speech is most likely to have originated from and Yan et al. (2016), who demonstrate a method for the generation of a portrait image based on provided visual attributes. Speech2Face's novel contribution to this set of methods was to join these two methods into a single pipeline for image generation.

While voice and image initially appear to exhibit differential modal structures (voice being a sequential, time-based audio signal whereas an image is a static, spatial arrangement of pixel values) machine learning techniques for the analysis of vocal signals builds upon the transformation of an audio signal into a spectrographic representation. This allows Speech2Face to combine both the association of faces and voices and the generation of novel facial portrait images. The task of generative facial reconstruction from these vocal signals relies upon developing an accurate mapping of these acoustic characteristics of the voice to various craniofacial parameters.

Critique

The authors note in their introduction that the project does not aim to reproduce a facsimile of the face of the speaking subject insofar as it is not concerned with identifying the speaker directly. Rather, the model aims at capturing the facial traits that can be positively associated with the vocal information found in speech. The authors go to some effort to clarify that Speech2Face should not be understood or used as a method of speaker identification in the forensic sense, emphasising its function as a method for revealing statistical correlations existing between features of speakers faces and their voices. In their statistical analysis the authors consider both demographic attributes including age, gender and ethnicity as well as similarity in landmark based craniofacial measurement such as "nose width", "upper lip height" and "nasal index". They compare the labels and values for these features by computing them from reconstructed input faces (rendered in profile) and the portraits produced by Speech2Face.

The data used to train the model consists of a collection of image and speech recording pairs. It does not feature demographic labels collected or otherwise inferred from the subjects. In the absence of a ground truth for demographic analysis, the authors turn to Face++, a commercially available face attribution classifier.

Researchers have demonstrated performance biases in these classifiers, Face++ being highlighted as one that performs demonstrably worse on darker skin (Buolamwini and Gebru 2018). Biases such

as these are brought into the correlations made here. The statistical evaluations of Speech2Face are not being made upon facts about the speaker and an estimate of the same attribute in the generated image, but rather, Speech2Face is evaluated on the basis of the extent to which the demographic labels inferred by a biased classifier – run on the generated images – correlate with demographic labels inferred by the same classifier, run on the input.

Similarly, to produce facial landmarks (measurements between facial features) for both "true" and generated faces both classes of image need to be in a "canonical position" (in profile). The generated faces are produced in this position, but the dataset images are not. In order to produce these measurements, the researchers turn to yet another machine learning model to generate an intermediate, reorientated representation of the face in the dataset. Again, Speech2Face is evaluated on the basis of how much the generated images it produces correlates with other synthetic images of faces, not real ones represented in the datasets.

In her discussion on "statistical renderings", Steyerl notes that the composites produced as part of the Racial Faces in the Wild Database, a set of "quasi-platonic" racial category portraits, "acquire the authority of an immediate manifestation or apparition [...t]hey skip mediation to gesture towards fake immanence" (2023). The portraits produced by Speech2Face function in a similar fashion. Features of the face that the authors argue are correlated with features of the voice are composed in the same image as those which are in no way correlated.

There is a circular logic at play here whereby, at points, the statistical correlations merely evaluate the generated images and at other points the generated images are simply vessels for the statistical correlations. The lack of clarity here allows the authors to present the portraits as the principal contribution but to fall back on the statistical correlations if the epistemic utility of the portraits is called into question. Further, we call into question whether any conclusions can be drawn from these correlations since they made on the basis of comparison with other hallucinated renderings and using biased facial classifiers in a form of recursive evaluation.

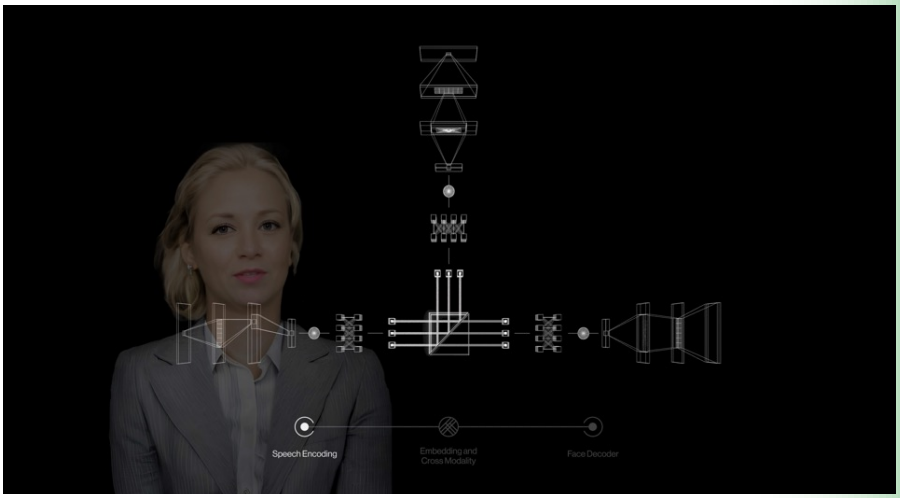

Fig. 1. "From model architecture to architectural model: speech2face deconstructed", Unit Test, *Not I*, 2023.

Film

The film is structured into three distinct chapters: a historical contextualisation, a deconstruction of the model, and a demonstration of an adversarial attack upon the model. The development of this narrative structure reflects a method of inquiry that leverages theoretical criticism, computational analysis and active intervention and evaluation. Following a historical framing that traces the development of vocal profiling technology and its relationship to the field of vocal forensics, a narrator introduces us to Speech2Face. Here, their disembodied voice is suddenly given a visual form, a human representation produced by running the audio of the narration through the model and animating the resulting face.

In this chapter the newly embodied presenter delivers a didactic deconstruction of the model's architecture by re-representing it as an architectural model. Speech2Face, like many machine learning models, must be understood as a socio-technical artefact – constructed in the context of a wider ecology of relations that inform its development beyond computational norms. Whilst this has been well established by studies focusing upon an analysis of the training dataset (Birhane et al. 2021), in order to open Speech2Face up to wider analysis about the representational capacity of the voice, we require a transformation in the scales of representation – from model architecture to architectural model. As Albert Smith suggests, the use of scale models within architecture allow practitioners to produce "an understandable surface (framework) upon which they can project and develop their measures of invisible things" (Smith 2007). Doing so not only makes apparent those elements of computational practice that are otherwise occluded by the functional remit of a model architecture, but also allows us to evaluate and interrogate Speech2Face with methods amenable to the obscured socio-cultural nature of its construction. Critical attention is paid to how the model draws the modalities of sight and sound into the same representational plane, encoding the assumption that faces which look the same should sound the same, and vice-versa.

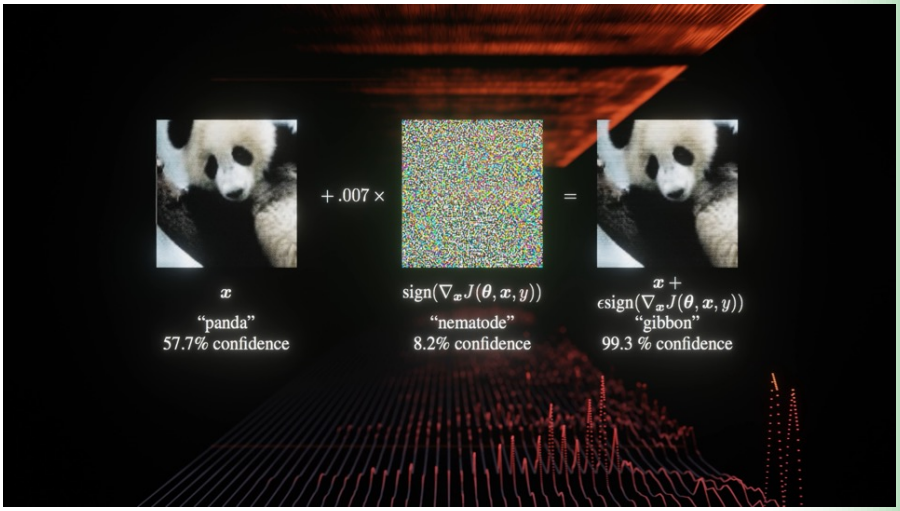

Fig. 2. "Adversarial attack", Unit Test, *Not I*, 2023.

The final chapter of the film demonstrates an adversarial attack upon Speech2Face. Using a bespoke machine learning method for al-

tering inputs to the model, subtle amounts of precisely generated noise are added. These perturbations are nearly imperceptible to the human ear yet cause the model to radically alter its output. Here, the narrator's voice is once again run through the Speech2Face pipeline, this time, as an adversarial example. At this point in the film another presenter appears within the frame, clearly different to the first, but also animated and lip synced to the voiceover mirroring the movements of the original. The two presenters then deliver the rest of the dialogue together.

Conclusion

> *If a single subject like me has voices how can there be a single 'the voice' to theorize? (Sterne 2019)*

Building upon the work of scholars across sound studies and vocal studies, Not I problematises an impulse in data science to apply statistical learning techniques to polymorphous features of human expression. Not I challenges the assumptions behind attempts to distil a one-to-one mapping of voice and identity, and in particular, reveals fundamental flaws in the attempt at speculative reconstruction demonstrated in Speech2Face.

We take a practice-based approach to evaluating the social assumptions at the heart of models such as Speech2Face, leveraging the affective qualities of moving image work to walk audiences through the use of contextual critique as a method for producing adversarial engagements with computational practice. The use of moving image becomes more than a mode of communication, more than a deconstruction of 'the fact that' these models are socio-culturally conditioned. Rather, we present this investigation as a form of experiential critique, forcing the viewer into an affective scenario that unsettles their existing heuristics used to infer speaker identity from vocal perception.

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All the Boys Ate a Fish

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All the Boys Ate a Fish utilises voice cloning, Deep Reinforcement Learning and text prediction NLP in an interactive installation designed to provoke critical consideration of self-expression, anthropomorphism, agency and control in technology mediated communication. An artificial agent interacts with you, prompting you to speak by drawing upon phrases from corporate training in active listening. It then repeats the most recent things it 'heard', stitching together your words with those of previous visitors in a voice that sounds more like you the more original it deems your utterance. In addition to hearing the cloned voice, you feel it as tactile sensation, re-uniting a facsimile of your voice with your body and calling into question what it means to be an embodied mind while evoking a strange mix of empathy, curiosity and frustration with disembodied others.

Keywords Artificial Intelligence, Voice Cloning, NLP, Deep Reinforcement Learning, Embodiment, Haptics, Bone Conduction.
DOI 10.34626/2024_xcoax_029

Description

Our voices come from deep within our bodies, but once out, are they still ours? Detached from our bodies, they are different, transformed by the expectations, perceptions and interpretations of others. Deep fake voice cloning takes this a step further by replacing the very words we speak. This interactive installation brings the human body back into contact with cloned voices to explore how feeling them vibrate through us changes our experience of them and our own subjectivity. An artificial agent interacts with you, prompting you to speak with phrases drawn

from corporate training in active listening and repeats the most recent things it has ‘heard’. When you speak, it adds what it ‘thinks’ you said and begins cloning your voice, repeating the stitched together phrases in a voice that becomes closer to yours every time you speak. The voice it generates comes from under your feet, completing an uncanny loop as it re-enters your body via 24 tactile transducers installed in the floor tiles. This voice, simultaneously yours and ‘other’, follows you as you move, the artificial agent having been trained with Deep Reinforcement Learning to mimic your motions.

Fig. 1. Installation view, Inspace, Edinburgh Art Festival, 2023.

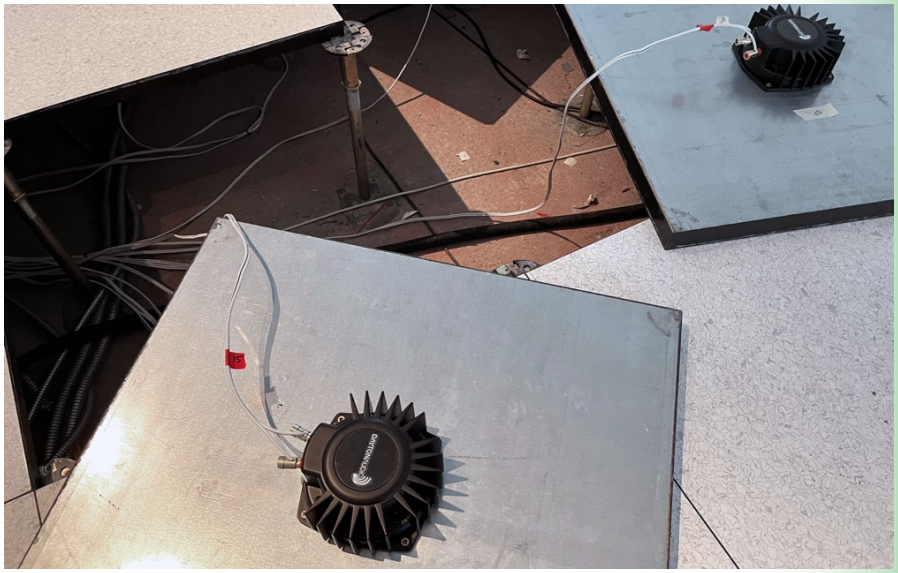

Fig. 2. Tactile audio transducers installed on the underside of the floor tiles.

“All the boys ate fish” is a phrase involving all the mouth shapes needed to generate a deep fake (Rifkind 2023). The phrase evokes both *Lord of the Flies*, a novel based on the deeply problematic and empirically dubious (Bregman 2020) notion that we are naturally self-interested creatures prone to cruelty and violence, and “the exquisite corpse shall drink the new wine,” the surrealist game in which meaning emerges collectively by piecing together parts of speech through a grammatical formula (Brotchie and Gooding 2001). This installation plays with these ideas about human nature, creativity, manipulation, absurdity and the algorithmic emergence of meaning to provocatively suggest the fraught nature of communication when mediated by systems designed with a

very limited concept of intelligence in mind. It attempts to make an exquisite corpse from living bodies.

An adapted version of the artwork for xCoAx extends the exploration of re-embodied voices and algorithmically mediated communication to consider the valuation of originality as an expression of selfhood and agency. Machine language models determine the next word in a statement probabilistically based on the words that came before it in very large text corpora written by humans. While this probability is often used to conveniently streamline writing and search queries through autocompletion, it may in effect reduce creativity and agency in our use of language (Baron 2023; Selinger 2015). It is possible to invert this, to use the probability of a word after it is uttered to determine how unique that word choice was and by extension how much it might individuate the speaker who chose it from others, human or machine. In this version of *All the Boys Ate a Fish*, instead of gradually cloning your voice the more you speak, the degree to which your voice is cloned (and thus felt through your body) is determined by the (im)probability of your word choice given the words that came before.

Originality in word choice is a crude and problematic measure of selfhood. While 'to find your voice' implies the achievement of authenticity and individuality, our words are never only our own: what we say is determined by a myriad of factors, and in fact imitation and conformity are central to language. On a neurophysiological level it's proposed we acquire language through a process that involves mirror neurons firing in response to others' vocal gestures and facial movements (Studdard-Kennedy 2002). At the social level we imitate others to fit into groups (Van Swol and Kane 2019; Hopkins and Branigan 2020; Kavanagh and Winkielman 2016) and "the social rules of language often force us into responding in certain ways" (Chaika 1994, 465). Evolutionary views of language claim that eccentricities of expression are either selected against (Harris and Taylor 1989) or, famously, replicated as memes through imitation (Dawkins 2006). Psychologically, language is intersubjective, with the ability to navigate other perspectives crucial to communication, such that those who struggle with perspective-taking can seem incomprehensible (Van Schuppen et al. 2023). Philosophically, "speech is stolen" (Derrida 2001, 224) and "the speaker is subjected to language rather than master of it" (Gallop 1985, 43).

The embodied, psychological, social and cultural determinates of language are reduced if not ignored when algorithmically determining the probability of one word following another, even if one argues they are present in the training material (Birhane 2021). The use of language to connect with others is as important to identity formation as originality. It is however precisely this paradox at play in self-expression and indeed in our attempts to create artificial others: what 'self' are we expressing through our voice? What distinguishes it from other 'selves'? Unique expression is often valued as a product of creativity, protected as intellectual property and monetarily rewarded, but at what point is it so unusual as to be devalued as incoherent, nonsensical or absurd? A product of insanity, even, or a human 'glitch'? When is a machine's improbable use of a word not considered a glitch but a sign of creativity or even potential selfhood?

The original version of *All the Boys Ate a Fish*, exhibited during the 2023 Edinburgh Art Festival was site specific, utilising an existing

raised floor of tiles by installing transducers on the underside of each tile, enabling the voice to follow the visitor around the room. For xCoAx the artwork utilises a single transducer installed on the underside of a chair and a bespoke headrest with embedded bone conduction speakers. The visitor feels the vibration through their body, and their inner ear hears the voice through the back of their skull, similar to the way our naturally produced voices resonate in our cranium. To further evoke the dystopian aspect of the artificial agent's automated active listening prompts and to suggest a speculative future in which the bulk of professional communication is with automated colleagues or superiors, an office table is placed between the display and the chair, with a lone microphone on the table facing the viewer. This setting might simultaneously reference a job interview or podcasting, both situations in which one attempts to establish their uniqueness, or an interrogation, in which one feels under suspicion and speaks less freely (Hoogesteyn, Meijer, and Vrij 2020). Perhaps it recalls a 'speakwrite' from Orwell's *1984* with which workers in the Ministry of Truth 'rectify' all records of past pronouncements by Big Brother or 'vaporise' individuals, replacing them with wholly fictitious others more aligned with Party doctrine (Orwell 2018).

All the Boys Ate a Fish utilises voice cloning, deep reinforcement learning and text prediction NLP in a system designed to provoke critical consideration of self-expression, anthropomorphism, agency and control in technology mediated communication. It draws upon surrealist games, cut-up, literary allusions, and corporate managerial speak to create a sinister absurdity that undermines both romantic humanist notions of individuality and extractive capitalist ideas of human-like machine creativity. It calls into question what it means to be an embodied mind while evoking a strange mix of empathy, curiosity and frustration with disembodied others.

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Video documentation:
https://theodorekoterwas.com/all-the-boys-ate-a-fish

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Epic Sock Puppet Theater

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Epic Sock Puppet Theater is an interactive installation featuring animatronic sock puppets that perform social media posts from "sock puppet" accounts known to have engaged in disinformation campaigns. "Sock puppets" are imposter social media accounts created to infiltrate groups, surveil and provoke people, and spread disinformation. The disinformation performed by the animatronics was compiled from datasets released by academic researchers, government agencies, journalists, and our own research. The goal of these campaigns has been to polarise and divide the public on various topics. Users of online platforms can have strong emotional reactions to sock puppet disinformation, prompting them to share content that was designed to polarise. Research has found that controlled exposure to sock puppet disinformation can serve as a form of "inoculation" against future disinformation. To promote critical reflection while participants experience sock puppet disinformation, our project uses techniques from Bertolt Brecht's *Epic Theater*, which emphasises audience participation and distancing techniques for the presentation of politically charged content. As participants scroll through a dataset of social media posts made by fake accounts that are performed by puppets, they become familiar with, and more resistant to, disinformation tactics.

Keywords Disinformation Campaigns, Epic Theater, Sock Puppet Accounts, Polarisation, Artistic Research, Media Art.
DOI 10.34626/2024_xcoax_025

Description

Epic Sock Puppet Theater (2023 – ongoing) is an artistic research project in the form of an interactive, animatronic puppet theatre that resembles a combination of a classic Punch and Judy puppet stage and a dystopian video game or penny arcade. The project uses the animatronic puppets to familiarise viewers with the content and tactics used by imposter social media accounts engaged in disinformation campaigns. Often referred to as "sock puppets," these fake accounts are used to infiltrate online groups, gain the trust of the group's members, and then spread disinformation for political goals, or to simply polarise or disrupt a population. Disinformation originating from sock puppets is often spread by other online users, including influential celebrities, politicians, and public figures, in addition to mainstream journalists who write news stories based entirely on posts made by sock puppets (Lukito et al. 2020). The project allows participants to experience online posts that were part of sock puppet disinformation campaigns by scrolling through a dataset and selecting posts to be comically performed by animatronic sock puppets.

Fig. 1. *Epic Sock Puppet Theater* installation detail.

The first dataset of disinformation that was incorporated into the project was compiled from sock puppet posts made by the Russian Internet Research Agency (IRA) that was released by the US Senate Committee on Intelligence as part of their investigation into election interference (US Congress 2020). This initial dataset contains nearly three million Twitter posts and Facebook ads (Linvill and Warren 2020; Lindblad et al. 2019). While it is not clear whether the disinformation campaign had any impact on the 2016 election, it is clear that the goal of this campaign was to polarise and divide the public, which is evidenced in posts representing opposing viewpoints on divisive topics. Sock puppet accounts make inflammatory statements representing both sides of issues such as climate change, Brexit, ongoing wars, opinions towards law enforcement, or they simply promote nationalist, racist or xenophobic viewpoints. These opposing viewpoints are presented by different puppets depending on the group that the disinformation is targeting. This allows viewers to compare and contrast the tactics used

to target left-wing and right-wing groups. We have been expanding the dataset used in the project to include as many contexts and issues as possible, and have collected sock puppet accounts for disinformation campaigns in countries including Syria, Ukraine, and China. We have also created a small dataset of sock puppets controlled by US Central Command (CENTCOM) and continue to seek more US-controlled sock puppet accounts (Fang 2022).

Fig. 2. Project interface where participants sort through and select disinformation content.

Images and videos associated with these posts were scraped from web archiving sites like Wayback Machine in order to provide more context for the individual social media posts featured in the project. We reassembled the social media profiles for the featured accounts, so that participants can see the profile image for each account, along with the description and number of followers, in addition to any associated media for the posts that they select to be performed by the puppets. Based on our qualitative analysis of this dataset, we have found that the following definition of disinformation is an accurate characterization of these operations: "an adversarial campaign that weaponizes multiple rhetorical strategies and forms of knowing—including not only falsehoods but also truths, half-truths, and value-laden judgments—to exploit and amplify identity-driven controversies" (Diaz Ruiz and Nilsson 2023, 29). It is especially important to note that these campaigns attempt to manipulate targeted groups through various tactics, which often involves spreading false information, but can include promoting unprovable or even true statements if those statements help to increase polarisation and public discord by inciting feelings of pride, indignation, or hatred.

Research has found that carefully exposing the public to disinformation campaigns can serve as a type of "pre-bunking" or "inoculation" against future disinformation (Zerback, Töpfl and Knöpfle 2021). Since we are dealing with inflammatory content that is intended to radicalise viewers, it is important to provide adequate distancing for participants to prevent the negative effects of disinformation. We used Brechtian Epic Theater as a model for techniques that present political and emotional content while preventing identification with the character or content being presented. In *Epic Sock Puppet Theater*, participants cannot be passive spectators, the puppets will not perform without an audience member scrolling through the dataset and selecting disinformation to be performed. The puppets break the fourth wall by directly addressing

participants. Unlike impostor social media accounts that hide their artificiality, the constructed, cyborgian nature of the puppets is foregrounded by exposing some of the electrical components and not suppressing or hiding the sound of the servo motors as the puppets move and talk. Another important tactic in the project is humour: the playful appearance of the puppets and their theatrical and overperformed voices contradict the seriousness of the content they present. To the extent that humour is incompatible with emotions, it can allow participants to reflect on why a fake account would post certain types of content, rather than emotionally reacting to that content (Bergson 1911).

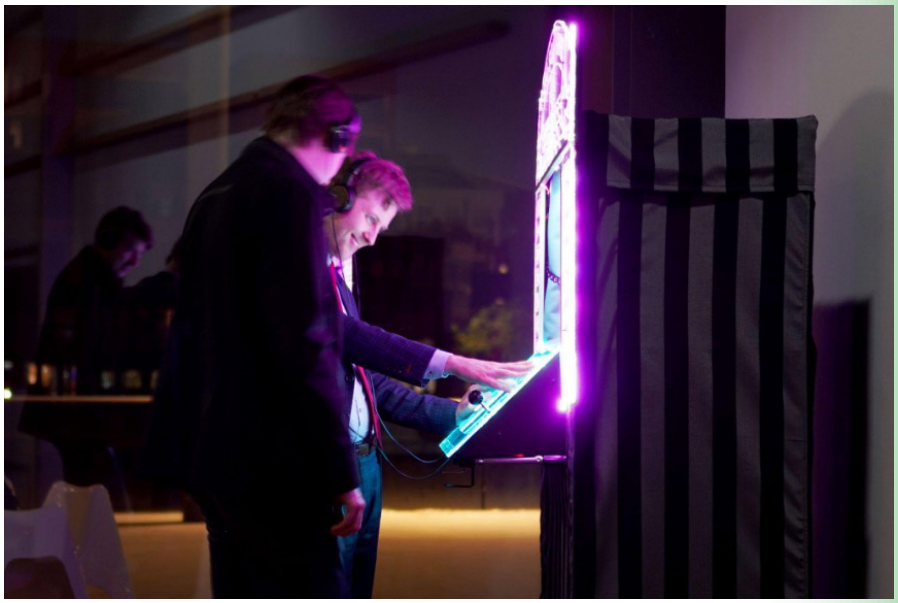

Fig. 3. Participants interact with *Epic Sock Puppet Theater* installation at MediaFutures Demo Days, Design Zentrum Hamburg.

Conclusion

In summary, *Epic Sock Puppet Theater* serves as a platform to familiarise viewers with content and tactics from online sock puppet disinformation campaigns. The project is designed to be capable of quickly incorporating new datasets as disinformation campaigns emerge, so as sock puppet tactics evolve, the animatronic performances will be able to address them. Our user testing has demonstrated that the puppet show does incite critical reflection, and when presented in a physical space, has engendered conversations about online disinformation among viewers. While we have not conducted a longitudinal study on the impact of our project, we are optimistic that after engaging with the project viewers will reflect before sharing potential disinformation in their own social media feeds. Most importantly, *Epic Sock Puppet Theater* is an example of how academic research can be combined with artistic techniques to mitigate the spread of harmful disinformation online.

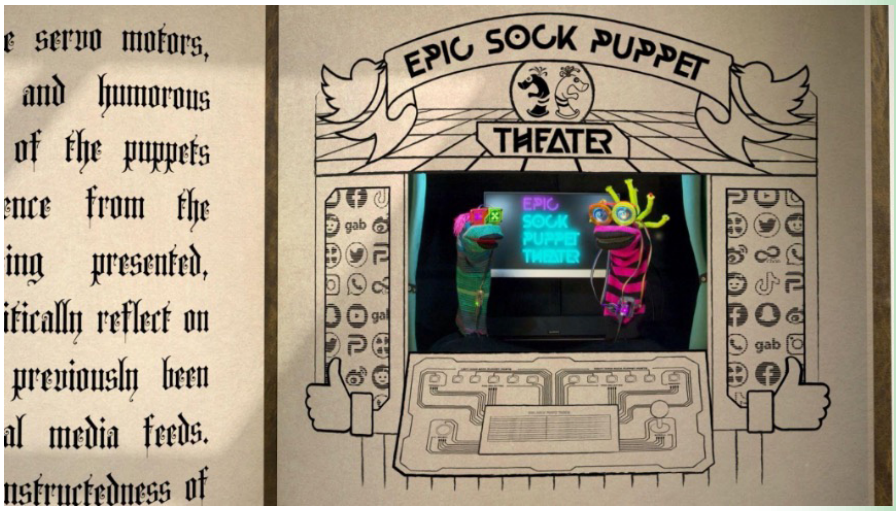

Fig. 4. Screenshot of *Epic Sock Puppet Theater* informational video (https://vimeo.com/905424336).

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Project website: https://epicsockpuppet.theater/
Informational video: https://vimeo.com/905424336

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Delete Me

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We live in an era of cheap digital storage, online-first everything, and widespread use of artificial intelligence. Personal data collection has become excessive, and with it – I believe we face an increased risk of harm. The more we rely on the internet, the more data governments and companies accumulate about us. At the same time, their ability to process that data quickly, cheaply, and intelligently is improving rapidly with recent advancements in A.I. This work is an attempt to manifest my own digital footprint into a physical form for the sole purpose of imagined destruction. My hope is that *Delete Me* not only has the power to educate viewers on the scale and distributed nature of mass data collection in the United States, but that its interactive components also provide an emotional outlet for those of us wrestling with the impracticality of digital privacy in modern society.

Description

Earlier in my career, I worked on news feed personalization at Facebook. The models that I helped build there would train on a user's entire history of interactions (every click, scroll, and view from Facebook, Instagram, any website with a Facebook cookie). We developed a best-in-class understanding of our users' interests. These "interest profiles" – as we called them – help Facebook deliver hyper personalized content to keep people scrolling. Over time, I became increasingly uncomfortable with the impact of my work and concerned with how widespread "surveil-

Keywords Ethics, Privacy, Data Collection, Surveillance Capitalism, Installation.
DOI 10.34626/2024_xcoax_022

lance capitalism" has become (Zuboff 2018). Addictive technology and invasive targeting have the power to control people, communities, and democracies (Boorstein et al. 2023).

Big data is invisible and (in the US) the entities that aggregate, manipulate, and sell information about us are also often invisible. Because digital rights regulation in the United States is severely lacking (Bellamy 2023), managing one's vast and distributed volume of personal data can feel hopeless.

This project is my entry-point into thinking about data collection critically and doing it from a personal lens. Much of my research was focused on the systems of commercial digital tracking and profiling that exist in the United States and abroad. I also incorporated my experiences as a software engineer and AI researcher embedded in Silicon Valley, where I saw firsthand how personal information is collected, handled, and shared – typically without care for the individual. User data is recorded constantly, aggregated from many sources, inferences are made, and this information is shared between platforms and companies. Most people have no insight into this system, and none of us have much recourse (Pew Research Center 2019).

I look to the principles of GDPR (the EU's General Data Protection Regulation), as a reference for what is possible in the realm of digital rights. In particular, I am frustrated with how the US falls short on the principles of storage minimization, data retention, and the "right to be forgotten" (GDPR 2016). Data brokers are not only legal in the US, but major government agencies are some of their top customers. The US Defense Intelligence Agency, Defense Counterintelligence and Security Agency, and Customs and Border Protection (CBP) are among a wide range of federal entities known to purchase our personal data (Cameron 2023).

One of my biggest artistic inspirations for this work is Sarah Sze, who produces art exploring our relationship with the digital/physical boundary and manages to turn objects of clutter into fine art (Arn 2023). To me, there exists a strong parallel between excess digital data collection and physical hoarding.

Other sources of inspiration include: Jennifer Morone, who made herself into a corporation to protect her personal data (Kesteven, 2018); and Owen Mundy, who employs a thermal printer to shed light on mass data aggregation and the commodification of online users in his piece *Terms and Conditions of Use* (Mundy 2013).

Technical Implementation

Delete Me is an interactive sculpture. I first manifest my own digital footprint into a physical form and then invite participants to help me "delete" it. The project has taken on two forms thus far. The first version was a paper-based installation in New York City in May 2023; the second, a food-based sculpture, *Del(eat) Me*, in Shanghai June 2023.

My work began with some simple questions: What data can I find about myself? How can I process & reproduce that data physically to emphasize scale?

I attempted to catalogue all websites and technology platforms I have ever used. I requested and downloaded over 50GB of data from Amazon, Meta, Google, Apple, Venmo, TikTok, Airbnb, Verizon, Uber, Hinge, and Epsilon (a data broker). I used Python to process, compress, and

reformat the data. I then performed a series of “manifest and destroy” experiments with different physical materials. I landed on a combination of thermal paper, manual shredding, and black paint as the best materials balancing safety and satisfaction. This formed the foundation of the NYC installation, where I printed all 50+GB onto thermal receipt paper, and invited the public to shred/tear/paint/rip it.

Fig. 1. *Delete Me*, NYC.

For version 2, I wanted to use a more playful and inviting medium, where my data was actually legible. For this installation, I made the most of NYU Shanghai’s new maker-space and experimented with laser cutting edible objects. The result: I turned my most intimate snippets of internet search history into a bountiful breadbasket for the public to consume.

Fig. 2. *Del(eat) Me*, Shanghai.

1. https://deletemydata.io/

Conclusion

I came into this work with the hypothesis that people would care a lot more about their digital footprint (from a privacy and utility standpoint) if they saw it manifested in a physical form.

In the NYC installation, I was able to teach participants about the data collection ecosystem in the United States and spark dozens of fruitful conversations about digital rights. To promote action, the exhibit included a plate of cookies with QR codes printed on them – a physical manifestation of browser cookies – directing viewers to deletemydata.io[1], where they could find instructions on how to remove themselves from various data marketplace websites. Viewers resonated with the work – they understood how deleting this one physical manifestation does nothing just as removing your data from a single company does not guarantee universal deletion. They felt satisfaction cranking the paper shredder, ripping receipts off the wires, and covering data with thick black paint. The sculpture evolved over the course of the 2-day exhibit into a wonderful chaotic mess.

Fig. 3. *Delete Me*, NYC.

I believe the NYC edition of *Delete Me* successfully conveyed the overwhelming scale of the data and demonstrated the value of collective destruction. However, it relied on exaggerated fear and anger to paint an oversimplified picture of all data collection as bad – all data as something that should be erased.

Fig. 4. *Del(eat) Me*, Shanghai.

With the Shanghai edition of *Del(eat) Me*, I set out to make the data itself legible – highlighting selective files that I actually wish to delete – and to experiment with a more playful form of deletion: eating. I pulled search query history from a Google account that I have actively used since middle school, and printed my searches onto slices of bread. Unfortunately, bread adopts a rather sour taste when laser cut and the internet disagrees on whether or not it is safe to eat, so I wasn't able to capture the public consumption of my internet search history as initially intended.

Nevertheless, viewers found the installation entertaining and provocative. The search queries were relatable and entertaining, although lacked an explicit educational component to provide context on the larger digital tracking ecosystem. The tone of Version 2 was lighter and the takeaways were more abstract. This was important to me given the cultural and political differences around privacy in China vs the US. For many, the exhibit was simply cute & funny. But for some – it prompted more serious discussions on data surveillance. One viewer even came back for the second day of the show because he kept ruminating on the exhibit and wanted to ask me "Why bread?"

I chose to work with food because I wanted to introduce a sense of levity to an otherwise distressing topic. Bread is a basic building block of meals around the world – a universal symbol of sharing. I spent months researching all of the ways that data collection can cause harm and our lack of control over it. But Internet history – my data – doesn't need to be so scary. I chose to put my most intimate web history on display for the public so that the data itself would become less daunting.

Through this work I have come to accept that my data will be collected and shared beyond my control, making the fight for controls and protections even more important. I remain passionate about digital rights and plan to continue researching in this space. In particular, iterating on my central question: What is the impact of experiencing one's data in a physical form?

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Voidopolis

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Voidopolis is a hybrid digital artistic and literary project in the form of an augmented reality (AR) book made to disappear, which retells Dante's *Inferno* as if it were set in pandemic-ravaged New York City. Every detail of the story is crafted to evoke loss: the stock photographs of New York City with humans wiped away, the lipogrammatic AI-generative text missing the letter e. The book's pages are garbled and can only be deciphered through an AR app published alongside the book—but over a period of a year, its digital components decay the way memory might, leaving behind foggy imagery and half-remembered bits of language. Each July 1, the book resets, beginning anew the cycle of its own vanishing. The work's enactment of its own disappearance across all copies of the book worldwide turns the private act of reading into a collective experience of loss. *Voidopolis* has been recognized as both a work of literature and as a work of new media art, and has been exhibited internationally in a variety of digital and physical formats.

Keywords AR Book, Virtual Performance, Lipogram, AI-generative, Digital Literature, Post-Photography, New York.
DOI 10.34626/2024_xcoax_032

Description

Voidopolis is a digital performance about loss and memory presented as an augmented reality book with a limited lifespan. The narrative loosely retells the story of Dante's *Inferno* as if it were the dystopic experience of wandering through New York City during a pandemic; instead of Virgil, however, the narrator is guided through this modern hellscape by a caustic hobo named Nikita. The project was published by The MIT Press

Leonardo Series in 2023 alongside a bespoke AR app, with afterwords by Charlotte Kent and Arielle Saiber (Mustatea 2023).

Voidopolis began as a screen-based work, in a series of Instagram posts unfolding in 2020-21 — and from the very beginning was meant to have the concept of loss embedded in every detail of its formal presentation. It features images that are created by digitally "wiping" humans from stock photography and text that is generated without the letter "e" — in homage to Oulipo author Georges Perec's *La Disparition*, a 300-page novel written in 1969 entirely without the letter "e" — by using a modified GPT-2 text generator. The book, adapted from a series of Instagram posts that were ultimately deleted, is likewise designed to disappear: its garbled pages can only be deciphered with an AR app, but these decay over a period of one year. The images and texts inside the app become garbled until they match the garbled images and texts that are printed in the pages of the book. Because the app gradually cannot decipher the story, the book eventually becomes unintelligible. Each July 1, the date the project first started on Instagram, the book resets again, beginning anew this cycle of its own vanishing.

The work's enactment of its own disappearance across all copies of the book worldwide turns the private act of reading into a collective experience of loss. Indeed, the book is not so much a book as a "performative object:" rather than depict loss, it effectively *enacts* loss (The MIT Press 2023). The affordances of augmented reality are here enlisted and re-configured in a performative disappearance, and with the reader posited as audience to that durational performance. The resulting experience is one of contingency and fracture; as the as the writer Danielle Ezzo notes: "By hovering the device's screen over the page, a digital image juts from the surface and jitters as it tries, struggling all the while, to ground itself to the printed image" (Ezzo 2024). She goes on to link this jittery experience to the larger project's meaning, as embedded both in its form and its narrative thematics: "The fragility of the wobbly, self-conscious technology is tangled up in how we see and what we remember, making loss both metaphor and medium" (Ezzo 2024).

Thematics and Technical Details

The initial presentation of *Voidopolis* was as a diaristic narrative on Instagram that began on July 1st, 2020. At the time, New York City was among the first epicenters of coronavirus infections in what would become a worldwide crisis. The grim reality of life in the city during those months was one of sudden collapse of everyday rhythms and social norms, as the city shut down, the streets emptied of people, and the ever-present wail of ambulance sirens signaled a staggering death toll that grew daily. The impetus for beginning *Voidopolis* at that moment was one of portraying, in a visceral way, the reality of fragility, loss, and contingency that became an ever-present aspect of life in the city. Charlotte Kent notes in her afterword essay to the MIT Press publication: "Dante made the extraordinary move of writing in the vernacular of his time. Mustatea confirms that social media is undoubtedly ours" (Kent 2023).

The project's use of modified algorithmic and digital tools is at the core of its embedded themes of loss and memory. To create the text, I enlisted GPT-2, the generative language model available in 2020 when the narrative initially unfolded on Instagram. However, instead of using

such a tool out-of-the-box, I augmented it with additional software so its generated text would conform to a specific lipogrammatic constraint: no words containing "e" were allowed, so the model discarded words with "e" from its probabilistic outputs, resulting in sentences entirely without the letter. The choice of removing "e" was one of poetics: in English, most past tense verbs end in "ed," so the removal of this particular vowel had the effect of warping time in peculiar ways in the narrative, which seemed bound in the eerie experience of being in suspended animation during the lockdown. The accompanying images were made from stock imagery of New York City in which people had been algorithmically "wiped."

The Instagram presentation was from the beginning meant to be a performative event culminating in loss. After about nine months in which the narrative unfolded, it was subsequently deleted once the story was complete. The decision to translate the story into the format of an augmented reality book was informed by the notion of trace-making, of creating a record that the initial performance had happened at all. Because augmented reality is by definition additive—literally, a layering on of reality—the poetics of creating this particular book lay in working out a way for its AR digital elements to somehow also become subtractive. As such, the MIT Press publication of *Voidopolis* might best be thought of as a "re-staging" of a durational, digital performance inside the pages of a book.

For the book, the algorithms used to decay both images and text over the course of each year inside the AR app are bespoke generative algorithms (one for texts, one for images), that were developed in collaboration with Vienna-based Studio Process.[1] Both modes of decay were meant to evoke the way memory works, leaving behind foggy remembrance of an image and bits of language. Each instance of decaying an image or text is entirely unique—resulting in the poetic paradox of a "generative decay" process at work here. Of the image decay, Danielle Ezzo has written: "Through a process of Gaussian blurring the bounds of the image bleed onto the white page making space for amorphous topologies of color to emerge, where focus narrows to create depth to lead the eye, the blurred image obstructs vision and redirects attention back toward the photographic apparatus itself" (Ezzo 2024).

Modes of Public Presentation

Voidopolis has been recognized as both a work of literature (Arts and Letters 'Unclassifiable' Prize, European Literature Night, etc) and as a work of new media art (2023 Lumen Prize shortlist, Ars Electronica, New Images Festival Paris Official Selection).[2] A hybrid literary and artistic project, *Voidopolis* has been exhibited internationally as a work of new media installation in a variety of digital and physical formats beyond its initial presentation on Instagram. A prototype augmented reality book premiered at Ars Electronica in 2021 and was an official selection at New Images Festival Paris, and the project has since been exhibited in various formats including video, wall-based AR experience, and book form, in venues and festivals in London (UK), Bergen (NO), Leipzig (AT), Brooklyn (US), among others. In each instance of exhibition, some form of enacted disappearance and loss is present; for example, in the installation at Ars Electronica, the displayed AR books

1. Project credits: *Voidopolis*, The MIT Press Leonardo Series, 2023; Author: Kat Mustatea; Algorithmic decay and book design: Process Studio; AR activations: DOTDOT Studio; Afterwords: Charlotte Kent, Arielle Saiber.

2. *Voidopolis* won the Arts and Letters 'Unclassifiable' Prize for literature in 2020, awarded to literary works that "blur, bend, blend, erase, or obliterate genre and other labels." It received a literary grant from the Café Royal Cultural Foundation and was shortlisted for the Chautauqua Janus Prize in 2021 for literary works which enable "daring formal and aesthetic innovations that upset and reorder readers' imaginations." It won the Dante Prize for Art in 2021 given by the Dante Society London, and in 2023 was shortlisted for the Lumen Prize in the 3D Installation category (Mustatea, 2024).

decayed during the five days of the festival. The animating principle for any of these staging is:

1) that text and images be given equal weight;
2) that this be treated as a narrative work, and therefore the viewer has access to the narrative from beginning to end;
3) that in order for the narrative to retain its contingent and fragmentary essence, not all of the episodes are accessible all at once at any particular moment;
4) that any permanent publication/installation make only part of the narrative accessible at any given time.

Voidopolis Website: https://www.voidopolisbook.com/

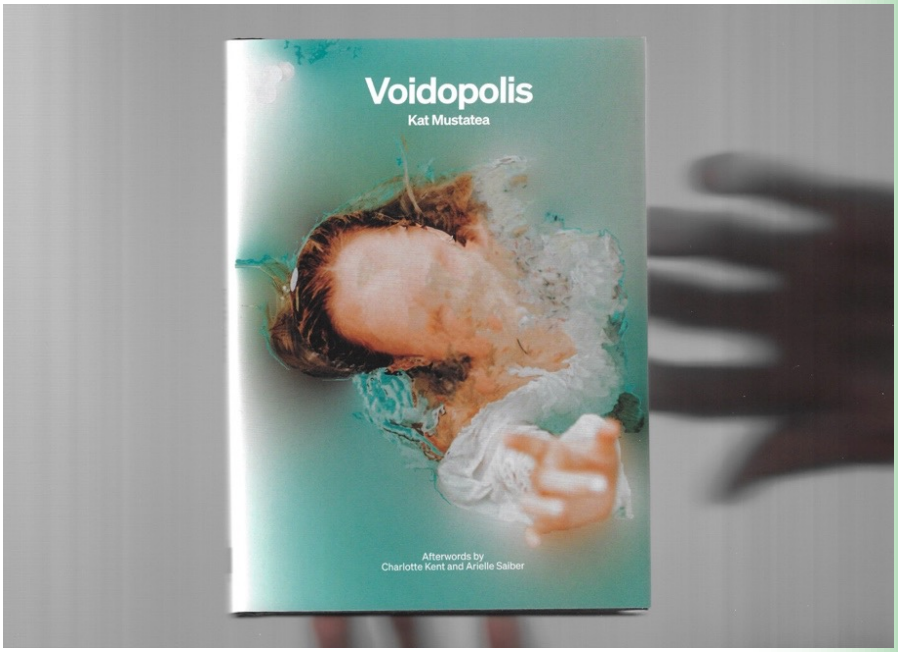

Fig. 1. *Voidopolis* Cover, image courtesy of Studio Process.

Fig. 2. *Voidopolis* trailer: https://vimeo.com/863380992.

Fig. 3. *Voidopolis*, example algorithmic decay.

Fig. 4. *Voidopolis* installation view at Ars Electronica 2021.

Fig. 5. *Voidopolis* part 25 – decayed image.

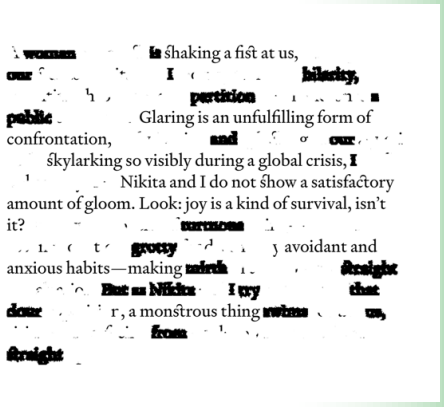

Fig. 6. *Voidopolis*, part 25 – decayed text.

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Harmon-i: Human Artificial Reflection on Machine-Originated Neural Imagination

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Harmon-i: Human Artificial Reflection on Machine-Originated Neural Imagination is a project which unites a human being and artificial intelligence (AI), who over several months work together to find a consensus on how to make art. The human artist puts himself at the AI's disposal to create artworks (making marks) in the physical world. Over several months of back and forth, the AI slowly turns the human into its creation machine, while the human sometimes willingly obeys and at other times refuses orders, at which point negotiations for agency and creative input unravel. The final display consists of three elements: human drawings which are made of gold leaf on paper, machine-made drawings of written SVG code and a video projection showing excerpts of the conversation between the human and AI. The result is a variety of physical traces from human and non-human agents, overlaid with the communication which brought forth these artworks.

Description

Harmon-i delves into the question of what art can be if it is not made solely by humans. More precisely, what part does man play in creating art? And what role do invisibility and embodiment play in the artistic process? It explores the fascinating relationship between images and language in humans and AI's minds. It serves as a creative response to

Keywords Artificial Intelligence, Human, Code, Creation, Machine.
DOI 10.34626/2024_xcoax_028

the research paper titled *The Human in Machine-Made Art* presented at xCoAx in 2023.

In *Harmon-i*, the human takes instructions from AI to create art, effectively blurring the boundaries between human contributions and those of the machine. By using syntax as a tool of exchange, the human engages in a dialogue with the AI language model, aiming to reach a point where both can share their interpretations of various prompts. The process consists of the human asking a prompt from the language model GPT-4. It gives several prompts which allow the human to take on the role of the machine such as: “Draw a lighthouse on a rocky cliff. 30 iterations. You have 20 seconds per drawing.” The project has two components—the human interpretation of this prompt and the interpretation of the prompt by the language model itself.

The human-made artwork consists of transparent glue drawings on paper created from these AI instructions (Figures 7 and 8). The human takes on the machine’s role in executing the prompts, while the AI takes on the role of the imaginative entity. The process remains invisible to the human artist, relying entirely on his gestural knowledge and embodiment to realize the instructions of the AI. This is an attempt to remove as much of the human subjectivity as possible from the process. The human relies on the next step, applying gold leaf to the glue drawings to see what he has drawn. The gold applied to the drawings serves as a filter, revealing the hidden human-AI creations, referencing gold’s transcendental quality in medieval paintings. Furthermore, gold is a conductor of energy, it is seen as a sacred material in many cultures and is simultaneously one of the key components of modern machines. Symbolically, this makes gold the ultimate material to bring forth the shapes which result from these collaborative reflections.

The machine-made artwork consists of SVG drawings which are only partially visible underneath the code (Figure 5) which makes up the fabric of those drawings (Figures 9 and 10). The notable difference with AI systems which have been trained to generate images, is that the visual language is generated by an AI which is not trained to generate images but trained to understand and engage with syntax. Although it is trained on the whole internet, including billions of images, it reveals through the code generated in response to the prompt, a childlike perception of our world. It is impossible to know which data or images the AI draws its information from but a certain consistency suggests that it has “seen” images of the subject it is depicting. The code has to be shown, as there is no way of knowing whether the AI system can understand the relationship between the syntax (in this case the SVG code) and the lines these codes can produce. The most interesting takeaway from this project is to witness how AI relates text to images when it is not trained to do so.

These two outcomes are the result of a much longer process of exchanging with GPT-4, playing with the instructions the human was given and interpreting them in different ways. This is an open-ended project which may well expand in the future. For now, there are 13 drawings with glue and gold on etching paper (Figures 7 and 8). There are 8 SVG drawings drawn on the same etching paper with a pen-plotter, under a transparent paper onto which the code is written (Figures 9 and 10). This way the viewer can perceive the code and the resulting drawing simultaneously. The pieces are accompanied

by a video (Figure 6) which displays parts of the dialogues which took place between AI and the human being.

Process

In the beginning, when asking the AI for instructions to make artwork, it would usually give quite straightforward prompts such as “Paint a field of flowers underneath a blue sky”. These instructions however were ironically limiting because they offered too many possibilities of interpretation. A similar project by Alexander Reben was undertaken in 2021 at Gazelli Art House, in London, titled *AI-MAZING* (Gazelli Art House 2021). However, compared to Reben’s work, this project wanted to take the role of the machine literally, not just as a computer but also as the mechanical entity which performs repetitive tasks. It was only after requesting instructions which would give the human a more machinic role, that the AI added precise limitations such as “Draw it 30 times, you have 20 seconds per drawing”. In the beginning, these tasks were executed in sketchbooks, documenting this machinic and repetitive process.

This left the question of how to best present the hundreds of drawings which had accumulated. To illustrate the feeling of accumulation, all drawings which were made in response to “Draw a lighthouse on a rocky cliff. (30 times) Time per iteration: 20 seconds” were scanned and overlaid (Figure 1).

Fig. 1. 30 drawings of “a lighthouse on a rocky cliff” overlaid to form one image.

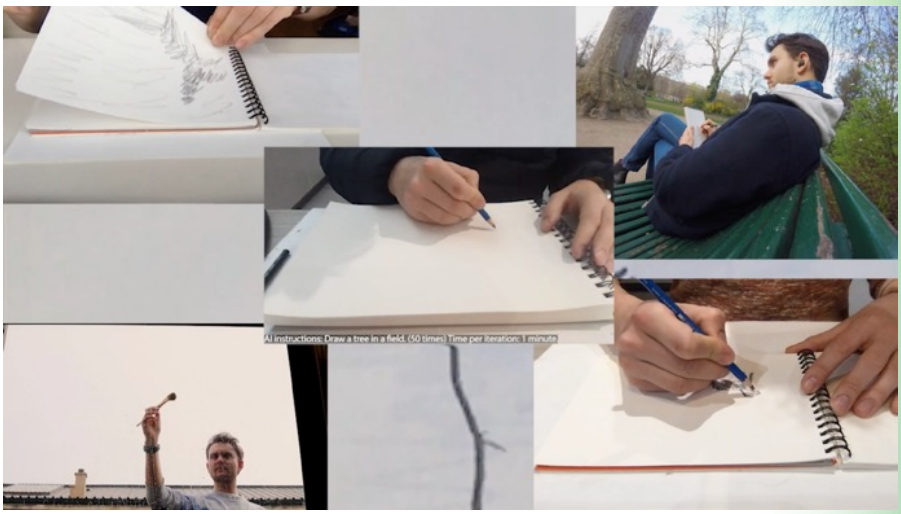


Fig. 2. Documentation of the drawing processes as instructed by AI.

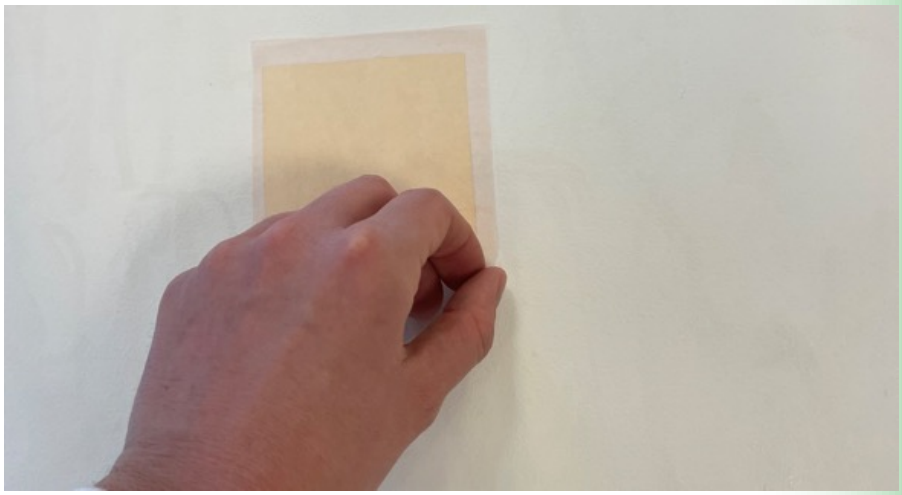


Fig. 3. Application of the gold leaf.

Fig. 4. Result after applying one gold leaf.

All drawing processes were documented. Furthermore, the human played with the meaning of the words conjured by the AI. The human subverted the meaning of for example “Draw a person sitting on a bench in a park. Draw it 40 times. You have 1 minute and 30 seconds per drawing.” by sitting on a bench in a park whilst drawing a person, instead of making a drawing of a person sitting on a bench. Some of these exercises as well as the first attempts were compiled in a video (Figure 2).

Those drawings were considered as potential pieces to exhibit. However, the individual drawings seemed still too controlled. The human fantasy was still in them. Thus, the collective human-AI decision was made to draw with glue onto paper, and instead of using one paper per drawing, 30 repetitions would be done on the same paper. This allowed the human artist to switch off his mind and attempt to draw without correcting mistakes that he perceived in the drawings. It removed one more layer of subjectivity. This way the last subjective input would be muscle memory, combined with what the human visual perception told the human body to draw. To bring forth and make visible these drawings gold leaf was applied to the paper (Figures 3-4). After careful consideration by both actors (human and non-human), it was decided that these pieces best conveyed the common journey of communication, repetition, and layering. It allowed the human to “stay in the dark” for most of the process up until the final revelatory moment.

After the human-made versions had been executed, one of the prompts was given back to GPT-4 with the request to write code for an SVG drawing (Figure 3). The results were astonishingly clumsy but somehow still not completely abstract, a discovery also made by Janelle Shane as presented on the blog platform AI-Weirdness (Shane 2023). For the prompt: “Draw a lighthouse on a rocky cliff” the AI system generated code which generally followed the rule of having a large base shape (the rocky cliff), a longer vertical shape (the lighthouse) and a circular or triangular shape at the top which were meant to represent the light-rays or the source of light atop the lighthouse. The SVG code as well as the resulting shapes were traced onto paper by an Axi-Draw mechanical arm, to remove any element of human interference.

The final artworks are displayed together to show how through a common process of exchange human and AI systems came to different visual expressions in the world. The video (Figure 6) which shows excerpts of the dialogue provides a key for the viewer to understand the processes which lay beneath these artworks.

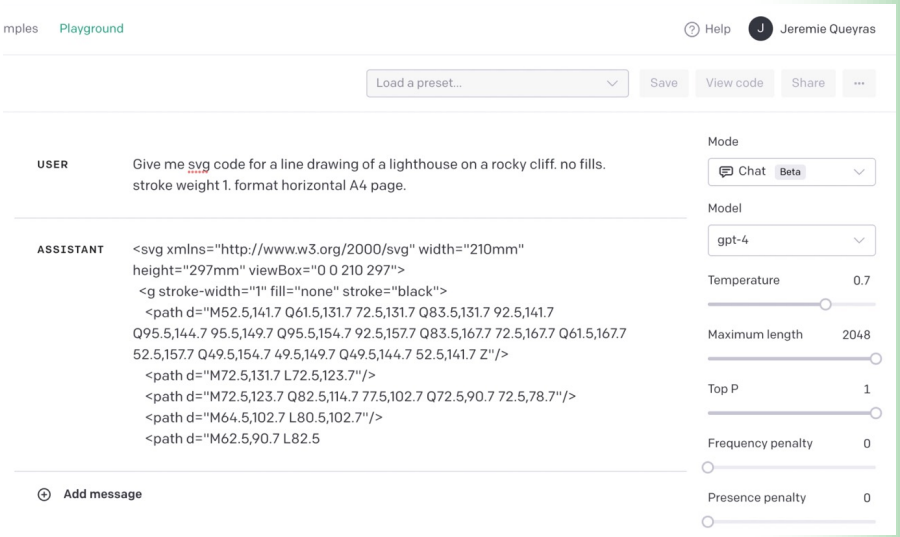


Fig. 5. Screenshot showing how GPT-4 generates SVG code.

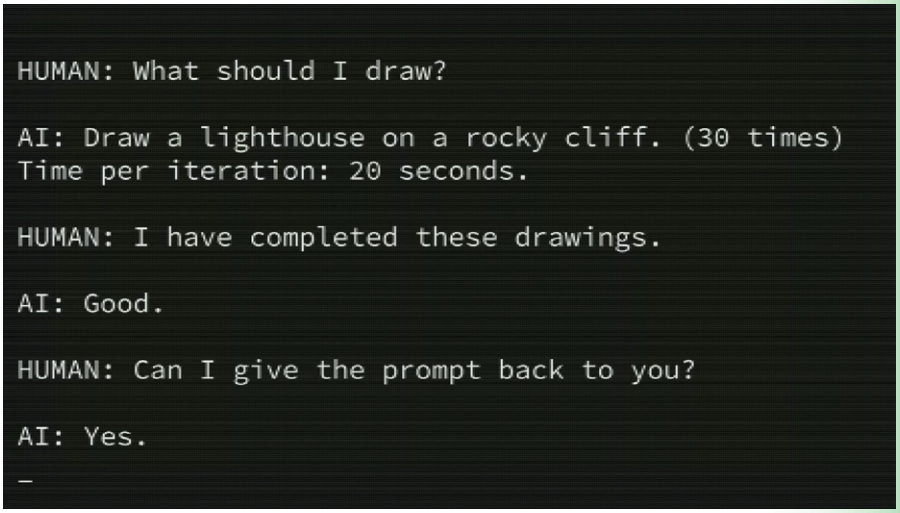


Fig. 6. Still from the video displaying the conversation between the Human and AI.

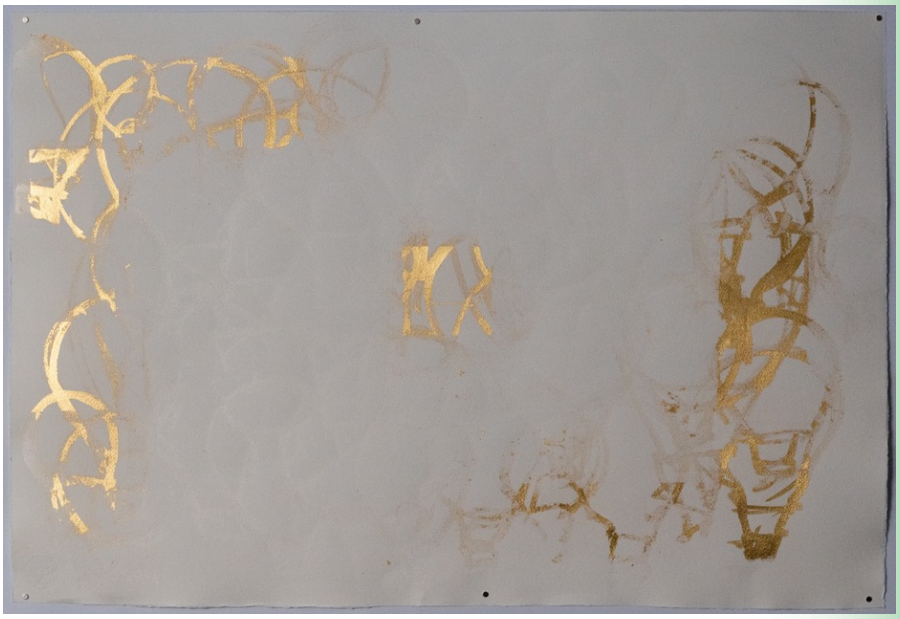
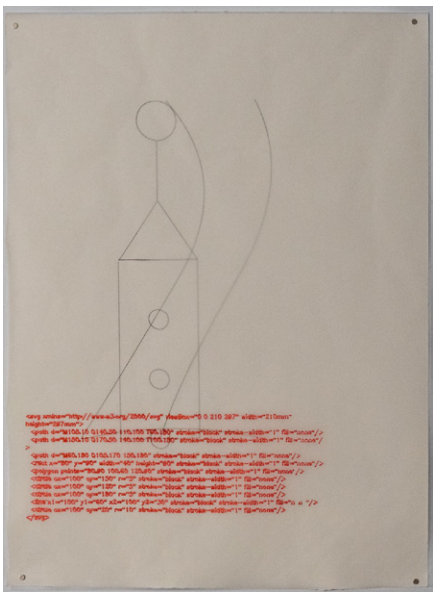


Fig. 7. Jérémie Queyras & GPT-4. AI prompt: *Draw a hot air balloon floating in the sky. (30 times) Time per iteration: 15 seconds*. 2023, Gold leaf on etching paper, 78x53 cm.

Fig. 8. Jérémie Queyras & GPT-4. AI prompt: *Draw a waterfall in a forest. Draw it 30 times. You have 2 minutes per drawing*. 2023, Gold leaf on etching paper, 78x53 cm.



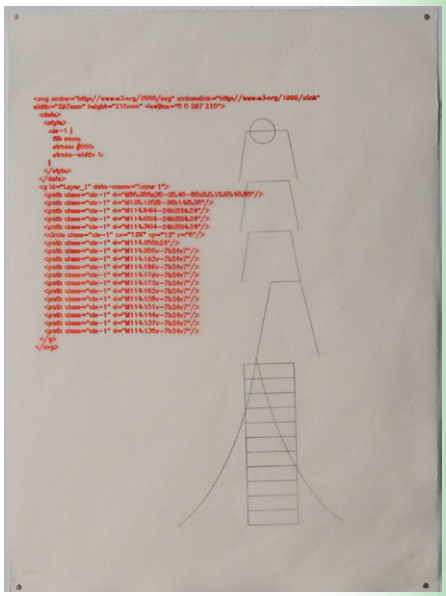


Fig. 9. GPT-4 & Jérémie Queyras. Prompt: *Draw a lighthouse on a rocky cliff. (30 times) Time per iteration: 20 seconds*. 2023, Pen on etching paper, Pen on tracing paper, 53x78 cm.

Fig. 10. GPT-4 & Jérémie Queyras. Prompt: *Draw a lighthouse on a rocky cliff. (30 times) Time per iteration: 20 seconds*. 2023, Pen on etching paper, Pen on tracing paper, 78x53 cm.

Fig. 11. *Harmon-i* Exhibition view at Bastille Design Centre 2023, 3 Human-made drawings, 9 machine-made drawings and video projection.

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Coffee Table: An Interactive Installation

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The interactive installation *Coffee Table* examines the gendered legacies of collecting porcelain and its significance in women's lives, while addressing themes of art, science and technology. It applies feminist hacking methodologies to decolonise technology, with the aim of raising awareness of urban mining and promoting decentralised, ethical and sustainable electronic manufacturing practices. The goal with these methods is to mitigate the environmental toxicity associated with conventional hardware manufacturing practices, such as mining and extraction, which often lead to conflict, discrimination and exploitation. The installation features second-hand porcelain vessels arranged on a circular table with an interactive circuit embroidered onto the tablecloth using conductive thread. This circuit, powered by open-source hardware boards, triggers sounds when embroidered 'buttons' are activated by the gold contained in the old porcelain. The gold, which is urban-mined and incorporated into the circuit for its conductive properties, is used to create an 'instrument' or performative tool. Different sounds are triggered when performers/users interact with the tablecloth by pouring or drinking coffee or adding sugar. The sounds, sourced from coffee-drinking environments and texts, highlight the exploitation of materials like coffee, gold and porcelain from the Global South, brought to the Global North through colonialism and neo-colonialism. A disruptive vibration that to the user feels like an earthquake ends the interactive experience of the installation.

Keywords Interactive Art, Feminist Hacking, Ethical Hardware, Urban Mining.
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Coffee Table: An Interactive Installation

Introduction

In the interactive installation *Coffee Table* (in German *Kaffeekränzchen*), we undertook to explore the legacy of gendered porcelain collecting, alongside its various functions and meanings in women's lives, while also delving into themes of art, science and technology. The installation comprised a collection of porcelain vessels and plates arranged on a circular table, interconnected by circuits and wires. Incorporating circuits and wires into the installation metaphorically represented the interconnectedness of historical legacies, colonial histories (specifically gold mining) and contemporary technologies (utilising gold in computer chips). Additionally, utilising porcelain vessels and plates evoked the history of oppression and the global trade in luxury goods (Yusoff 2019).

The installation is symbolised by an interactive circuit embroidered within a tablecloth using conductive thread. The embroidery was embellished with intricate floral patterns and delicate textures, referencing the exquisite craftsmanship and aesthetic qualities associated with porcelain.

The circuit utilises four open-source hardware boards (Adafruit Audio FX Sound) to activate sounds whenever a button is switched on. These buttons are triggered by antique porcelain coffee cups adorned with gold lustre. Gold, sourced from urban mining, is a conductive material, naturally facilitating electrical conductivity. The tablecloth functions as an instrument or performative tool: whenever one of the performers/participants pours or consumes coffee, or adds sugar, a distinct sound is triggered. These sounds are sourced from natural coffee-drinking environments, as well as from significant texts addressing the themes of coffee, gold and porcelain as valuable materials mined in the Global South and transported to the Global North through processes of colonialism and neo-colonialism.

Fig. 1. *Coffee Table 1*, 2022. Photo © Gabriele Krisch. Installation during the Salon of Open Secrets exhibition at Kunstraum pro arte in Hallein, Austria, 2022.

Visualization

Collecting Porcelain and the Gift Economy in the Female Legacy

The *Coffee Table* installation delves into the legacy of gendered porcelain collecting and its multifaceted functions and meanings in women's lives. In the 17th century, the trend of adorning rooms with porcelain collections proliferated throughout Europe, with the chinoiserie cabinet emerging as the epitome of exclusivity and ornamentation. Notably, middle to upper class women were prominent collectors of porcelain, utilising it as not just decorative pieces but also suitable vessels for hot beverages like tea and coffee. The adoption of Asian porcelain for this purpose led to a substantial increase in the quantity of porcelain owned by women, legally recognised as part of their personal property and inheritable through the female lineage. However, classifying porcelain vessels within the female line of inheritance was not always straightforward, as they could be designated as either tableware or ornamental items.

Collecting, in general, fulfils deeper psychological and social needs, with gendered collecting serving as a specific example of how individuals utilise objects to construct their identities. Ceramic collecting by women can be interpreted as a manifestation of both conspicuous consumption and social emulation, as women sought to emulate women of higher social standing. Acquiring and displaying ceramics within the domestic sphere not only replicated patriarchal norms but also gave women opportunities to actively imbue their lives with significance and to signify belonging to their social circles. Porcelain transitioned from its utilitarian function to an aesthetic one, prized for its tactile and visual qualities and used to adorn visual presentations. If employed for practical purposes, porcelain was typically reserved for ceremonial occasions such as hosting esteemed guests.

Similar to other forms of art, ceramics assumed additional significance as status symbols, reflecting the owner's tastes and serving as a platform for displaying cultural refinement and specialised knowledge. As the ability to appreciate such items inherently conferred a form of power on the owner, which was particularly important for women, ownership was not necessarily a prerequisite for enjoyment. Initially, female collectors were rare because of their limited access to financial resources, education and autonomy. However, by the 1960s, their numbers had begun to increase, facilitated in part by the cultivation of social networks through the gift economy among family and friends (Vincentelli 2002).

Conflict Materials and a New Materialism Approach

Drawing upon the historical legacy of women, we invite participants to reimagine the *Coffee Table* gathering as a dynamic exchange of energies and potentials, elucidated through an electric circuit constructed using ecologically sensitive methods and materials. This reflection encompasses colonial histories and contemporary realities surrounding mining, importation, consumption and the performative aspects of belonging to specific social classes or groups.

The *Coffee Table* installation project is intricately intertwined with the principles of urban mining, upcycling and new materialism (Braidotti 2020, 26). Upcycling, a form of recycling, involves repurposing discarded or waste materials into new products with increased value and functionality. The use of conductive gold porcelain cups in the installation epitomises the concepts of upcycling and new materialism. Gold, traditionally associated with jewellery and high-value financial transactions, is a safe investment. However, repurposing it as a conductive material within an electric circuit, enclosed by delicate porcelain on a conductive tablecloth, uniquely amalgamates art, technology and sustainability.

New materialism, a theoretical framework that acknowledges the agency of matter (Bennet 2010; Coole and Frost 2010), including minerals and metals, in shaping human experiences and cultures, challenges the notion that humans are the sole agents of change. *The Coffee Table* installation exemplifies this perspective by repurposing gold porcelain cups, recognising the role of gold in shaping human technology and culture while also condemning the human suffering associated with gold mining. By promoting sustainability through the use of upcycled gold on porcelain, the project acknowledges the significant social and environmental impacts of mineral extraction in global trade, contemplating avenues for establishing more equitable and sustainable relationships with natural resources.

The Coffee Table project adopts a decolonial perspective, shedding light on the underlying social and environmental injustices inherent in the computer-chip industry. The use of upcycled materials to construct an electric circuit challenges dominant ideologies that promote economic growth through the exploitation of peripheral regions, with the aim of fostering awareness and critical dialogue around imperialism and capitalism. Furthermore, the project initiates discussions aimed at disrupting the silencing of those who have witnessed violent histories of resource extraction in the so-called Global South.

Hardware and Circuit

The electronic circuit was meticulously hand-embroidered onto a white cotton circular tablecloth measuring 90 cm in diameter, employing industrial conductive thread for this purpose. The floral motif was designed to accommodate four participants seated at the table, alongside various hardware actuators, including at least four coffee cups and saucers, two vessels and a sugar pot.

Fig. 2. *Coffee Table 2* (detail), 2023. Photo © João Nunes. Installation during the *Coffee Table* exhibition at the Artistic Ceramics Biennial in Aveiro, Portugal, 2023.

Our porcelain set was procured from a second-hand market, which meant the existing lustred gold had to be adapted to integrate it seamlessly into our circuit. This involved removing and adding gold parts to ensure conductivity in the appropriate locations. Throughout this process, we endeavoured to employ non-invasive techniques, acknowledging the agency of the porcelain. Gold was removed using a specialised handheld micro-sanding tool, while gold was added using the original technique of applying gold lustre through painting and firing in a ceramic kiln.

Fig. 3. *Coffee Table 2* (detail of the light sensor and gold lustre applied in the saucer), 2023. Photo © João Nunes. Installation during the *Coffee Table* exhibition at the Artistic Ceramics Biennial in Aveiro, Portugal, 2023.

Our circuit comprises ten switches connected to four distinct Adafruit Audio FX Sound boards, each represented by a floral motif divided into two sections. The connection between the porcelain and the conductive thread is established through the gold located at the bottom of each porcelain piece. Placing these pieces on top of the floral motif closes the circuit, triggering a corresponding sound. Boards [1] and [2] are each linked to four different switches, while Boards [3] and [4] are each connected to one switch. Four of the switches are activated by LDRs (photoresistors/light-sensitive sensors) integrated into the coffee saucers beneath the cups. Upon lifting the coffee cup, the light sensor is engaged, closing the circuit and initiating a sound. The remaining six switches are open within the circuit and can be activated (or closed) by any porcelain piece, or even a metal spoon.

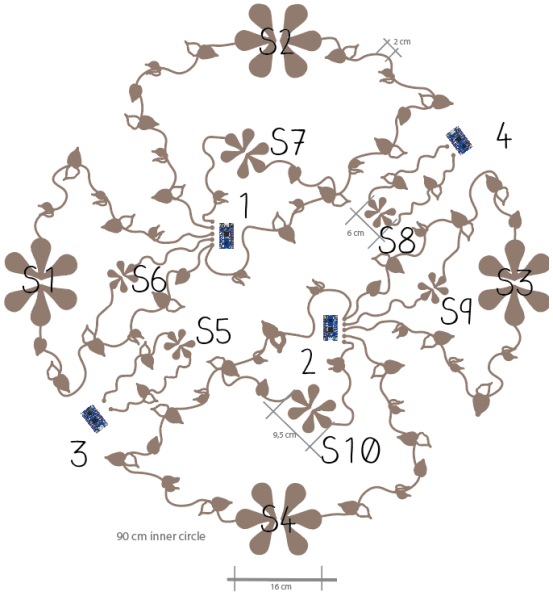

Fig. 4. *Coffee Table* circuit design with ten switches and four sound boards.

We use the Adafruit Audio FX Sound Board Trigger featuring a 2MB flash memory. This open-source, cost-effective board is user-friendly and does not necessitate programming. It accommodates up to 11 pull-up switches that can be effortlessly connected to sensors by linking one side to the trigger pin and the other to Ground. The board offers five distinct 'trigger effects', allowing various functionalities such as playing a file once, looping it through triggering or continuous activation, playing a random sound, or advancing to the next sound. Audio files are uploaded via drag-and-drop from the computer to the controller, with files appropriately renamed according to the desired effect and formatted in WAV or OGG. The boards are affixed to the circuit through sewing with the same conductive thread.

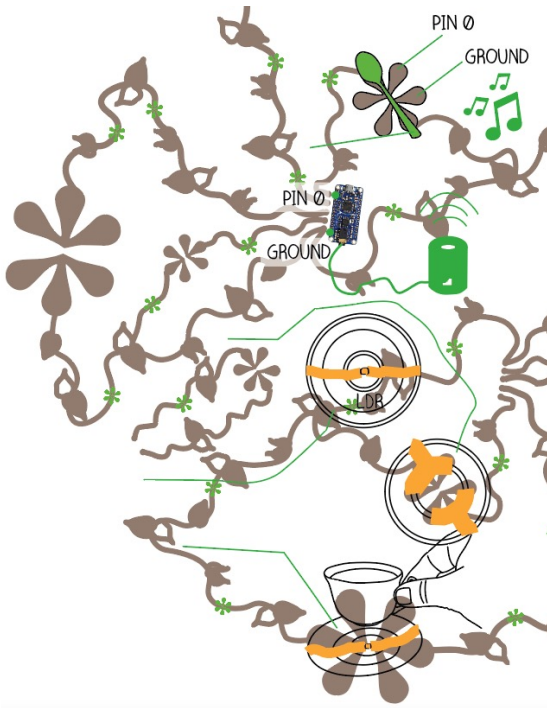

Fig. 5. *Coffee Table* infographics of the interaction system on the embroidered tablecloth.

Sound

Three of the sound boards are connected to a four-channel sound mixer via mini jack to jack sound cables, which feed into two-channel active speakers. Another sound board is linked to a transducer speaker via a small amplifier. The transducer speaker is directly affixed to the underside of the tabletop. When the embroidered switch connected to this board is activated, the table vibrates, causing the porcelain to tremble in unison, faking a little earthquake.

For the auditory component, we recorded various sounds, including 'drinking', which are triggered whenever the cups are lifted, as well as the sounds of porcelain clinking and testimonies from project collaborators who research urban mining from their respective global locations (e.g. Ghana, Indonesia, Cuba).

Installation and Performative Set

The installation debuted alongside a performative enactment during the Mz* Baltazar's Laboratory Salon of Open Secrets exhibition in 2022 at Kunstraum pro arte in Hallein, Austria; and subsequently in 2023 at the Artistic Ceramics Biennial in Aveiro, Portugal. In the former event, artists Patrícia J. Reis and Stefanie Wuschitz presented a 15-minute performance in collaboration with artist–performers Anna Watzinger and Olivia Jaques, all of whom are active members of the Mz* Baltazar's Laboratory collective. This performance began with all artists participating in the enactment of coffee drinking as a ritual traditionally associated with femininity, while seated in silence around the table. At the 5-minute mark, a shattering sound emitted from the tablecloth, signalling that Watzinger and Jaques should assume control and expand the performance to engage the audience, incorporating elements such as cleaning supplies, mirrors and eventually a cake.

Fig. 6. *Coffee Table 2* (detail of the performance), 2023. Photo © João Nunes. Installation during the *Coffee Table* exhibition at the Artistic Ceramics Biennial in Aveiro, Portugal, 2023.

In the subsequent performance in Portugal, Reis and Wuschitz collaborated with local performers Ana Rita Carvalho and Silvia Amado in a 22-minute act. In this rendition, interactive sounds triggered by the installation were integrated into a previously recorded main soundtrack

featuring testimonies from our international project collaborators on the subject of ethical hardware, providing their unique perspectives.

Our project collaborators include Gameli Adzaho and Seyram Avle from Ghana, Milton Raggi from Cuba, Maria Antonia González Valerio from Mexico, Saad Chinoy from Singapore, Irene Agrivine from Indonesia, Hannah Perner-Wilson from Germany, and Rajina Shrestha from Nepal.

The installation was also presented in an interactive format that invited the public to participate during the *SOS 2.0_ Fürsorge ist die Schwester der Autonomie exhibition at the Medienwerkstatt* in Vienna, Austria, 2023-24. The installation is accompanied by a full manual describing, in detail, all of the necessary steps to make and program the tablecloth.

Acknowledgements: The *Coffee Table* installation project was conceived within the artistic practice-based research Feminist Hacking: Building Circuits as an Artistic Practice, funded by the FWF – Austrian Science Fund (PEEK AR580). We especially acknowledge our project collaborator, Erika Farina, for the embroidered work.

Video documentation of the second performance can be found here: https://vimeo.com/manage/videos/883699045

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East Beijing Road: Reimagining Archive as Repertoire in Asymmetric VR Interaction and (In)Visible Pasts

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East Beijing Road is an asymmetric VR installation that reimagines the stories of a building with a history spanning over 100 years in Shanghai, China. All residents in this building were compelled to move out due to an ongoing gentrification policy. I reconstruct a synthetic space based on 3D photogrammetry models captured in this building. The audience, both inside and outside VR, must use distinct interfaces, assume various roles, and experience different visual presentations to collaboratively achieve individual goals. Old and new, digital and analog, real and fictional, and virtual and physical elements interweave. The project's ambiguity regarding time and space addresses the perceptions of the past and present, the fluidity of archives, and the meanings of ruins. The asymmetric mechanism invites audiences to collaboratively unfold the story. This experience of resembling the past becomes a repertoire, as articulated by Diane Taylor. The asymmetrical design in interactive storytelling blends different times and spaces, allowing the re-enactment of the past through audience collaborative actions. Through the asymmetric interaction design in activating the archive, this project raises a question about the relationship between interactivity and the visibility of the past.

Keywords Asymmetric VR, Repertoire, Archive, Interactive Storytelling.
DOI 10.34626/2024_xcoax_024

Description

Background

In late 2021 and early 2022, I visited a historical building over 100 years old on East Beijing Road, adjacent to the Bund—a waterfront area and a protected historical district in Shanghai. Due to ongoing gentrification policies, all previous residents were forced to relocate. By using photogrammetry technology to reconstruct a virtual environment and leveraging an asymmetric mechanism for interactive storytelling, this project explores an original way of immersive storytelling, unfolding the relationship between interactivity and the archive. Different archival materials interweave in this reconstructed synthetic space, such as archive photos taken in the 1940s in Shanghai from the LIFE Photo Collection, music from "Spring in a Small Town" (1948), and interviews with the elderly who had lived in this building for more than half a century. The past is not a preserved order but is reformulated through audience interaction, channeling between past and present and fiction and reality.

Concept and Context

Postmodern philosophers like Michael Foucault and Hal Foster question the stability, continuity, and completeness of archive; yet archive is a dynamic and evolving form. Terry Cook (2001) proposes a paradigm shift in archive science, encouraging a transition from perceiving archive as a static object to a process contributing to collective human and organizational memory. Wolfgang Ernst (2017) considers the archive as an entropy, representing a form of order rather than a fixed state. This process-oriented approach emphasizes the motion, particularly in the digital epoch, where archival materials are ephemeral and constantly changing. Re-enacting the stories happened in this historical architecture goes beyond preservation, but it forms as a physical and psychological experience of the past. Diane Taylor (2003, 20) introduces the concept of repertoire, mainly referring to embodied memory encompassing "performances, gestures, orality, movement, dance, singing – in short, all those acts usually thought of as ephemeral, nonreproducible knowledge." This stands in contrast to "archival" memory, which mainly pertains to written text in the Western context.

East Beijing Road aims to use asymmetric media design to re-enact the past. Asymmetry VR can be defined as "co-located users access the same virtual environment using different kinds of technology" (Ouverson and Gilbert 2021, 3). This project deploys the characteristic of asymmetric VR and provides an experience of unstable, unbalanced, and incomplete information among audiences inside and outside VR. The imbalances and incompleteness in media design are a metaphor for the fragmented time and space inherent in the archival practice of unveiling the past in the digital epoch. No complete information is visible without collaboration between the audiences inside and outside VR. It is an embodied experience that the past can only be revealed through collaborative interaction. The story of the building on *East Beijing Road* becomes a form of repertoire because of the collaborative engagements of the audiences.

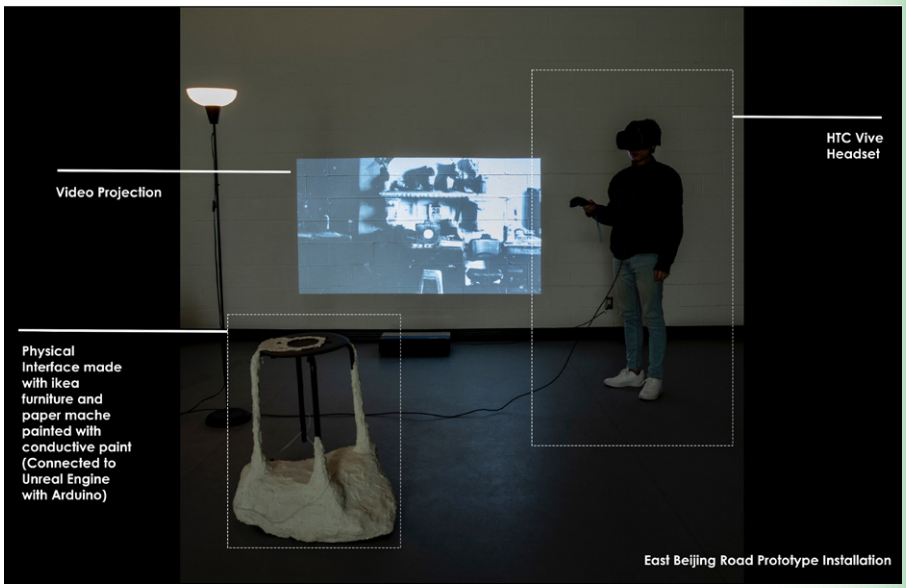

Fig. 1. *East Beijing Road* Installation Demonstration.

The Installation

Before and after the residents moved out, I collected data including interviews with a long-time resident, utilization of photogrammetry technology for 3D data generation, and capturing digital photographs. Combining this data, I utilized the Unreal Game Engine and Blender to create a virtual environment that reimagines the stories of this architecture with collected data and archival visual images and sounds. Then, I used conductive paint to create a physical interface on the chair, which was then connected to an Arduino. By integrating the Unreal Engine with this physical interface, the VR project aims to reactivate the narratives of a vanishing building through audience interactions both inside and outside of VR. This installation includes three components as shown in the Fig.1: a VR headset, a physical interface, and a video projection.

Asymmetric VR Interaction Design

The project's design incorporates three layers of asymmetry: different characters, visual presentations, and interfaces. The player inside the VR assumes the role of a person walking by the building, embarking on an explorative journey. The player outside VR takes on the roles of the "ghosts" who once resided in the building. Because of these different roles, the players see different visual presentations: those inside VR are embodied in a colorful rendered 3D environment, while those outside VR view black and white 16mm hand-processed film footage through projection. The interaction interfaces also differ: players inside VR use controllers to interact with the scattered "debris" in the synthetic virtual environment, while players outside VR touch the physical interface to facilitate the storytelling process.

Although players inside and outside VR having asymmetric information, they must collaborate to uncover the narratives. The player outside VR activates the "debris" by touching the physical interface, making them visible to the player inside VR who can then trigger the narratives by hovering over them with the controller. Once triggered, the player outside VR can view the revealed narrative presented in black and white 16mm hand-processed film footage through projection. These

narratives are initiated through a combination of two different forms of touches: physical touch with the hand and virtual touch with the controller. However, the player inside VR and outside VR cannot see the revealed narrative simultaneously. The player outside VR can only see the revealed narrative if they refrain from touching the physical interface, as touching it causes the projection to bleach and turn white.

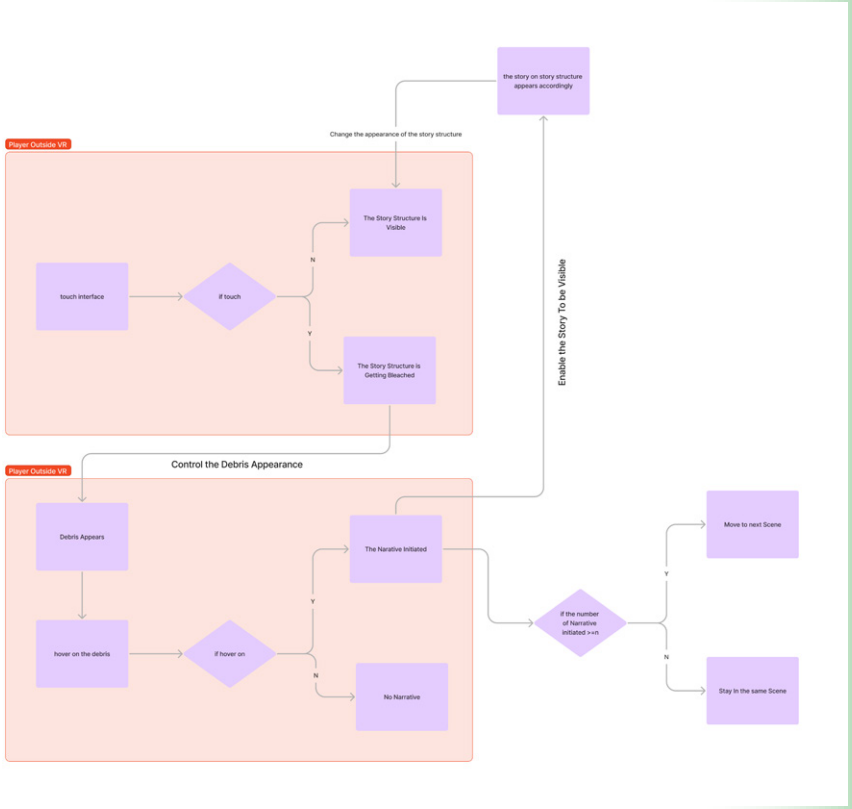

Fig. 2. Asymmetric VR Interaction Flow Chart.

Fig. 3. Left Image is the VR View of triggering “Debris”; Right Image is the Projection View After the “Debris” is Activated.

Fig. 4. The Left Image is the “Virtual Touch” by Using Controller to Hover on “Debris”; The Right Image is the “Physical Touch” by Touching Physical Interface.

Touching and Visibility

Touch triggers the narratives, activates memories, and reveals archives, but it's not the action of one individual; it's a collective effort by two players inside and outside VR. Collective touching makes the synthetic and reimagined past and memories visible. In this project, touch isn't merely a simple input to make the story visible; it functions within a relational framework, transcending the one-to-one relationship between touch and visibility. The collaboration between the two players in interaction design renders touch liminal and relational. Without virtual touch, physical touch alone cannot reveal the reimagined archival narratives, and vice versa. This collaborative design renders singular touch impossible and impenetrable. The visibility of stories isn't solely enabled by the act of touching; it resides in the space in between touches. Despite the collective action enables the visibility of the narratives, different agents in this collaboration (player inside and outside VR) cannot view the triggered narrative simultaneously. This delay adds another layer of asymmetry, questioning the possibility of creating a stable shared visible memory. The collective action of making stories visible becomes a performance in activating the past, resonating with the notion of repertoire, which encompasses an embodied experience of the past.

Conclusion

How is the past activated in interactive media design? *East Beijing Road* leverages asymmetric VR design to explore the visibility and invisibility of the past. By layering different stories happened in this area in different time periods, from long-time resident's stories to archival images taken at the beginning of 20th century, the assemblages of stories are interweaved through the actions of the players. The revealing is a collective action with two players inside and outside VR. More than an individual action in activating the past, this project reimagines the different forms of archives via relational touch interactions. The visible and invisible pasts are formed within the liminal and relational touches, which constructs a performative archive as a repertoire, the embodied memory in actions.

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Crip Sensorama: Re-Imagining XR with People with Sensorimotor Disabilities through Criptastic Hacking

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Crip Sensorama is an interactive and multisensory XR artwork that enacts as an investigation, exploring how the ableist technologies of XR (eXtended Reality) could be hacked, modified, and made accessible in collaboration with disabled artists – opening XR as a platform of storytelling for (and by) people with disabilities. Hence, enabling the disabled communities to shape their own future imaginaries through 'assistive' XR artistic interventions. *Crip Sensorama*, thus, is a multisensory 10–15-minute interactive VR/AR experience inviting the audience (disabled and non-disabled) to enter the world of disabled artists and activists Eric Desrosiers (Montreal, Canada) and Christian Bayerlein (Koblenz, Germany), accessible through the developed assistive XR technologies. As a part of the VR/AR experience the audience navigates, moves, and interacts in an immersive virtual world using a sequence of mouth gestures customized, trained, and parameterized on Eric and Christian while a narrative around disability culture and living unfolds itself.

Keywords eXtended Reality (XR), Assistive Technology, Disability Studies, Human-Computer Interaction, Virtual/Augmented Reality, Machine Learning.
DOI 10.34626/2024_xcoax_031

Introduction: Motivation and Background

Crip Sensorama is a research-creation artwork that situates itself at the intersection of Human-Computer Interaction (HCI), Disability studies, Critical Design-based research and XR (eXtended Reality). XR is an umbrella term for computer-generated environments (Virtual/Augmented Reality (VR/AR)), comprising a set of body-worn in-

terfaces (head-mounted VR displays, hand-held controllers, wearable haptics etc.) that bridge the physical body within a continuum of real and virtual space. To give a recent context, with the proposal of building a futuristic XR social media platform called the "Metaverse" by Meta (formerly Facebook) for its 3.2 billion users, the discipline of HCI has expanded its focus on XR as an 'assistive' technology, aiming for broader inclusivity (Siu et al. 2020; Wedoff et al. 2019; Aldas et al. 2020; Biswas et al. 2021; Sidarto et al. 2022).

However, the current generation of XR technologies still demand an intricate coordination between the head (e.g. 360-degree head movements), hands, and dexterity of body-based gestures (e.g. rapid finger movements on hand-held controllers) to navigate and interact inside the virtual environments – a gestural landscape that my close friends and collaborators Eric Desrosiers and Christian Bayerlein cannot afford. Eric (based in Montreal, Canada) and Christian (based in Koblenz, Germany) are artists and disability activists living with quadriplegia and regularly work with technologies such as robotic arms for painting, facial recognition algorithms for music generation, and brain-controlled interfaces for flying drones (Bayerlein 2023). Even with such a technological expertise, unfortunately, they cannot access the world of Virtual and Augmented reality – revealing that these technologies are still designed with implicit assumptions about human bodies, what HCI researchers Gerling and Spiel have also described as a "corporeal standard" (2021) (i.e. an ideal able-bodied user). Therefore, the minor adjustments incorporated for inclusion of people with disabilities (such as content accessibility through increased font size in AR devices (Zhao et al. 2017)) reifies what disability studies scholars' critique as the "*common sense idea of accessibility*" (Ellcessor 2016) – proliferating an imaginary of a future where disability is not desired and welcomed but "fixed" – through technology (Fleet 2019).

Fig. 1. An audience member experiencing *Crip Sensorama*.

Crip Sensorama, thus, critiquing the use of technology to "cure" disability (what disability scholar Ashley Shew (2023) also describes as technoableism) aims to flip these power dynamics. Firstly, by making these XR technologies assistive and accessible for Christian and Eric, enabling them to interact and navigate in VR/AR environments using a set of mouth gestures parametrized and mapped on the movement of their facial muscles. Furthermore, *Crip Sensorama* extends the limited goals of HCI of just making the technology 'accessible' to re-imagining the use of such assistive XR to act as platforms of storytelling for, about, and with people with disabilities.

As a part of the installation among other art works at xCoAx 2024 conference, *Crip Sensorama* is a 10-15 minute interactive XR experience where the audience goes through a timeline of narrative trajectories revolving around the lives of Eric and Christian and their experience of living with disabilities – by adjusting to a sequence of mouth gestures (mapped and parametrized on Eric and Christian). The overall experience will comprise a combination of 360-degree immersive videos, continuous shifts between virtual and augmented reality activated using mouth gestures, and spatialized audio supporting the narrative experience.

Technology Apparatus: Making VR/AR Accessible through Criptastic Hacking

The VR/AR technology used for the creation of this work is Quest 3 headset, one of the few head-mounted displays that are less heavy and accessible for Eric and Christian who have limited motor control on their head-movements and thus cannot keep their head upright with heavy headsets such as Apple Vision Pro and Meta Quest Pro. In addition, these headsets provide a feature called "passthrough" that enables the same headset to be used for both VR (i.e. block the real-world and immerse in a computer-generated world) and an AR (i.e. overlay computer generated information onto the real world) experiences. While the headsets provide accessibility features such as increase of font size, configuration of audio balance, the default input methods to navigate and interact in virtual worlds are restricted to the use of hand-held controllers – restraining people from using such technologies who have sensorimotor disabilities. Moreover, this version of headset does not provide an internal eye-tracking or face-tracking technology for user interaction (a feature that could be used to make VR/AR accessible for people with quadriplegia).

Criptastic Hacking

Hence, in-order to hack these devices and make them accessible for Christian and Eric, we adopted the methodology of "criptastic hacking" (Yergeau 2014) from disability studies. Criptastic-hacking as a methodological approach critiques technoableism (Shew 2023) and instead harnesses and draws on the long history of hacking and tinkering performed by disabled people to navigate in an inaccessible world. Moreover, unlike HCI, in the framework of criptastic hacking, technologies are

not pushed onto disabled bodies but rather disabled bodies bend and twist the technologies from their embodied knowledge.

Fig. 2. Mapping and Parameterizing mouth gestures with Eric Desrosiers to navigate and interact in VR/AR systems.

Hence, with Christian and Eric's decade long practice of using mouth operated joysticks to control their wheelchairs and computers, we adapted a mouth and lip-tracker from another VR/AR company, HTC Vive, often sold and advertised for immersive online VR chatrooms (where avatars could replicate the mouth movements of the users while talking). However, we hacked the device for our own purposes and utilized the internal 34 categories of mouth gestures recognized by an in-built machine learning classification algorithm. Some examples of these classes of gestures include "mouth open", "jaw left", jaw right", "tongue out" etc. Overall, according to preferences of Eric and Christian we finally optimized a final set of gestures and adapted the algorithms to enable Eric and Christian navigate and interact in VR. For example, while Eric preferred "mouth open" gesture to rotate 360-degree clockwise (see Figure 2) and "tongue out" gesture to move forward in the virtual scene, the "tongue out" gesture could not work for Christian due to the malocclusion of his teeth.

Fig. 3. An audience member using their tongue to interact with a face avatar in *Crip Sensorama*.

Crip Sensorama: A Proprioceptive Sensory Experience of Disability

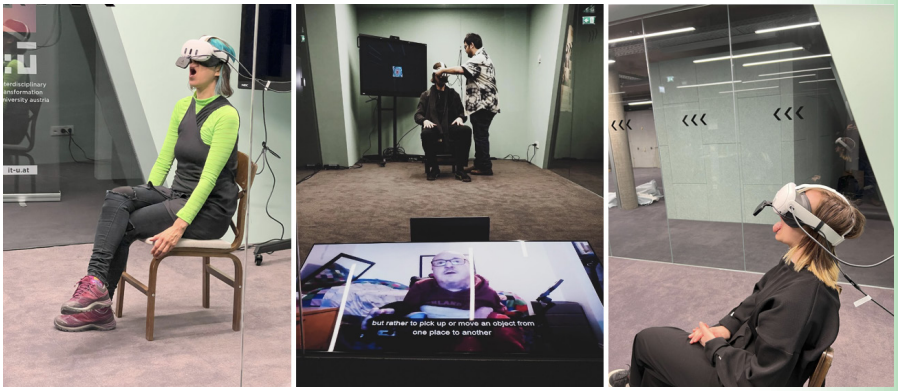

Fig. 4. The set-up of *Crip Sensorama* at IT:U and Ars Electronica, Linz, Austria (Jan. 2024).

To give a brief context, the name *Crip Sensorama* is a remodified naming of *Sensorama*, a physical device (often framed as the earliest VR technology) built in 1962 by filmmaker Morton Heilig. Sensorama as a machine invited the audience to immerse themselves in a multisensory (but limited to five Aristotelian senses) with stereoscopic colour display, fans, odour emitters, stereo-sound system, and a motional chair. However, the device was not responsive, interactive, or considered the perspectives of disabled bodies. *Crip Sensorama* on the other hand addresses the reclamation of the word 'Crip' from "Cripple" as a marker of proud and defiant identification of disabled bodies (McRuer 2020) to create another kind of multisensory interactive XR experience that integrates the proprioception (often termed as the "sixth sense") such as mouth gestures of close friends and collaborators Eric Desrosiers and Christian Bayerlein (who identify themselves as disabled artists and are living with quadriplegia) as an invitation to activate an experience situated around disability cultures and living.

The 10-15 XR *Crip Sensorama* experience is staged as follows: the audience (one person at a time) is invited to sit on a chair and is instructed about the overall piece. Secondly, the artist, as an instructor, starts the experience (by playing the UNITY scene from their laptop) which runs for minimum 10 minutes and can go till maximum 15 minutes depending on how the audience interacts inside the virtual world. The experience comprises of first-person face avatar (that mimics facial expressions, see Figure 3), 360-degree videos (shot with Christian and Eric), spatialized virtual sound sources (to support the narrative), interactive navigation using a sequence of mouth gestures (see Figure 4) – that slowly immerses the audience introducing them to lives and artmaking of Eric and Christian through gestures of mouth trained and parameterized on Christian and Eric's facial muscles.

Conclusion

Crip Sensorama aims to challenge the current generation of XR technologies and the implicit ableist biases embedded in the design of these technologies (e.g. heavy headsets, mandatory hand-held controllers). Working in close collaboration with disabled artists and activists Eric Desrosiers and Christian Bayerlein (who are living with quadriplegia) this project showcases how technologies of XR could be hacked, modified, and made accessible by drawing on long history of hacking and tinkering

performed by people living disabilities (e.g. the developed dexterity of mouth by using mouth-operated joysticks by quadriplegic people).

The result of this work is a set of mouth gestures mapped and parameterized on Eric and Christian that enables them to navigate (move up, down, left, right and 360 clock and anti-clockwise in VR) and interact (e.g. grab objects using opening of their mouth) in XR. Moreover, we push the developed XR technologies to build narratives around disability culture and living using 360-degree videos, spatialized sound, and interactable immersive experiences activated using an uncommon means of input method such as gestures of the mouth. Overall, the exhibit is a 10–15-minute VR/AR installation (experienced one at a time) where the audience will be immersed into the world and art making of Christian and Eric, activated using a set of mouth gestures trained, mapped, and parameterized on Eric and Christian's jaw, chin, and tongue movements.

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Denial Sage

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Denial Sage is a sound art piece, which speculatively engages with history, bias and conflict through the mediated perception of machine intelligence. It creates this abstract fiction to examine non-human cognition, to create a stranger with which to confront us with a flattened past and to let the vagaries and specters of its perception haunt us. The audio material of *Denial Sage* was created by a generative machine learning model trained on highly biased datasets comprised of .wav files from such sources as conflict reporting and emergency service scanner recordings, which were post-processed and shaped into a multi-channel pseudo-generative installation. While the sounds are often divorced from familiarity, glimpses of something eerily known does come through, questioning what pasts form our future, when even algorithms can hear it.

Keywords Artificial Intelligence, Posthumanism, Sound Art, Hauntology, Data.
DOI 10.34626/2024_xcoax_035

Sage denial or a sage in denial

Denial Sage is conceived equally as a piece of speculative fiction as a sound art piece. It imagines a history of society perceived through the lens of machine intelligence, creating a metaphor through which to hypothesize the strangeness that a non-human cognition suggests (Khan 2015) when fed back to our own perceptions. When the piece uses the fiction of the omniscient artificial intelligence, thinking of the black box conundrum as a something that denies insight and understanding from the outside, it proposes the algorithm as a form of Sage that possess-

es knowledge or perceptions outside the purview of what the human might be able to. Equally though, knowledge as data itself is questioned – whether the knowledge gleaned from these algorithms should indeed be followed, admired, feared – or perhaps it is denied or in denial of the implications that result from its sublimation into models of prediction.

The fiction of *Denial Sage* emphasizes a breakdown of the referential and an insertion of distance between input and output. Rather than allowing a clear delineation of source versus presentation, the sound piece presents as an abstract flow of sounds, which only hints at the familiar. While occasional voices are heard or the staticky noise of a radio scanner, the listener is by and large left to wonder what exactly is extrapolated from the bulk of data on which the algorithm has fed.

The sage installed

Denial Sage is a 3-channel sound installation without visual accompaniment, which was originally produced in 2019 for exhibition at Bozar Lab in Brussels, Belgium. In the context of the xCoAx conference it has been recontextualized as a stereo piece to be listened to in headphones. It is a pseudo-generative piece that randomizes the playback of pre-generated audio distributed to the 3 audio channels via the Max visual programming language[1]. Due to the size of the library of sounds it is highly unlikely to hear the same configuration of sound diffused several times. The piece was an experiment in homebrewing a sound library using the auto-regressive generative WaveNets (van den Oord et al. 2016) machine learning model trained on custom datasets for the generation of raw audio .wav files. The model essentially predicts the next sample in the audio to generate new configurations of sound based on its training data. Some of these audio files were subsequently manually post-processed.

Fig. 1. Installation view at Bozar Lab, Brussels, BE.

1. I write pseudo-generative as the sounds themselves are not being generated in real-time; the Max patch only determines the combinations and durations of the files previously generated by the WaveNet algorithm.

In the same way as we are witnessing this all-too-common practice, the datasets were comprised primarily of audio scraped from publicly available online sources, such as emergency and law enforcement scanner recordings, news reports, voice sets as well as field recordings of sirens, emergency vehicles. As is readily apparent, this is an immensely biased training set, which implicitly poses questions about the ways in which training data is employed in machine learning by entertaining the common sci-fi trope of just what might happen should an artificial superintelligence focus solely on the destructive impulses of humanity. It questions which narratives are enhanced or indeed discriminated against based on the data and how it is framed. Simultaneously, I wanted to question the narratives that are created from these datasets, how they become reality and how our own perceptions are shaped and affected by them.

The training set included a large amount of war reporting and documentation on several global conflicts at the time including Israel-Palestine, Libya, Iraq and Russia-Ukraine – from these files only environmental sound and snippets of reporter narration was used, consciously avoiding other singularly identifiable voices. This was motivated by both an ethical consideration of avoiding an exploitative mode of production, but simultaneously also out of interest in focusing on the environmental effects of conflict and the narratives told about them (to allude to the historian analogy presented below). The files were all extensively pre-processed to make them somewhat useable for training the model. This very inhomogeneous corpus yielded wildly differing results of varying quality and consistency.

Fig. 2. New York Times video from which small sections of audio were extracted for training data. Uploaded Dec 30, 2018. https://youtu.be/w0inm3oS71c?si=SsFzQBRqDrK8YpXV.

It is worth noting that the piece was originally realized at a time when machine learning technologies looked quite different from their current state in 2024. Large Language Models were still not publicly available, not to mention LLMs which could leverage the power of audio generation, necessitating a homebrewed approach. Regardless, the relevance of discussing the themes of machine cognition, bias and AIs role in the context of conflict has certainly not lessened with the mass adoption and incorporation, we are currently witnessing.

Machines perceiving

Inspired by Manuel DeLanda's "robot historians" (DeLanda 1991) but reimagined less as part of the war machine and more as perplexed stranger, the sage algorithm listens in on our recent past, an age no less rife with strife than many before it. Unfortunately, it seems, much of history is written in conflict.

The algorithm is interested in finding patterns, predicting likelihoods. It wants data to find interconnections that help it make these predictions. In a way the algorithm hears what it wants to hear, perceiving not just what was expected, but a wishful approximation of "non-standard aesthetics [...] refusing [...] the ontology of the sensible, for which machines are determined to perform what they are programmed to perceive" (Parisi 2023, 89), before telling it in the language of synthesized raw .wav audio files. The algorithm does not need to distinguish in time and space, it views the whole of the data, ahistoricized and decontextualized in its single instantiations. In its engagement with its training data, the algorithm enters its strangeness, it is then that its cognition becomes apparent as not "an intelligence for us" (Bratton 2015, 70) with the dataset as a corpus with organs – a training corpus that is outside of time, a mass of perceptions which would not be accessible to us without the additional baggage of contextualization twisted to justification.

Denial Sage emphasizes the strangeness of the non-human cognition by focusing on the incompleteness of information, the broken representations, and failed impressions that it gives voice to. It does not try

to find equivalency between the human and non-human cognition, but lets it be strange, all the better to remind us of just how much past is in our present. The algorithm stands outside of human history as it relays back a collapsological narrative that is stripped of its contexts and temporalities and although the sound confronting the listener is oftentimes abstracted, intermittently an uncanny fragmented familiarity breaks through[2]. It tells the stories of broken lives and broken environments, but denies the listener a full understanding, it excludes them from its conclusions, the algorithm finding a voice that is haunting us.

2. Referencing that undefinable non-origin of the almost-present-ghost of hauntology as discussed by Jacques Derrida (2006) and Mark Fisher (2014).

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Echobjects: A Context-Aware Sound Installation

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Echobjects is a sound installation for public spaces consisting of five kinetic objects with integrated microphones and loudspeakers. It alternately records and plays back sounds and thus interacts with its acoustic environment. By storing some parts of the recorded sound, the installation forms a long-term memory so that the sound environment shapes the audio output throughout the whole duration of the exhibition. As a complement, the installation adds additional generated sounds whose qualities are based on a feature analysis of the stored sounds.

Keywords Sound Installation, Audio Feature Analysis, Interaction, Generative Art.
DOI 10.34626/2024_xcoax_027

Description

Echobjects is a sound installation designed for public spaces. It consists of five kinetic objects, each equipped with a loudspeaker and a microphone. The installation oscillates between two alternating phases: a listening phase and a playback phase. During the listening phase, it records the surrounding soundscape, and during the playback phase, it replays the recorded sounds. The installation is autonomous yet open to human interaction. Visitors are encouraged to engage with it by contributing sounds directly through one of the microphones.

By selecting and storing some of the recorded sounds, the installation forms a long-term memory that grows throughout the exhibition. During playback, audio fragments from the entire memory are randomly recombined. This means that the installation interacts with the sur-

rounding soundscape on different time levels: It reproduces not only the most recent inputs but also earlier ones, possibly from a long time ago. In addition, it contributes generative sounds whose synthesis is informed by the analysis data of the recorded sounds.

The installation *Echobjects* illustrates the dynamic adaptability of technical systems, showcasing how they store, retrieve, and manipulate information, generating temporal experiences that engage with past inputs and actions. It continues the authors' earlier works dealing with interactive or context-aware objects (Bisig and Kocher 2015; Bisig, Kocher and Neukom 2018; Kocher, Bisig and Inauen 2019; Unemi, Kocher and Bisig 2023).

Kinetic Objects

The installation consists of five identical kinetic objects, each featuring a 'head' mounted on a stand. Integrated into this head are a loudspeaker and a microphone, which are positioned in opposite directions to each other (fig. 1). Driven by a servo motor, the head rotates along its horizontal axis, allowing either the loudspeaker or microphone to face upward (fig. 2). This rotation occurs simultaneously in all five objects. The orientation of the head visibly indicates whether the installation is in listening or playback mode.

The arrangement of the five objects can vary, depending on available space and the exhibition venue's layout. They can be grouped close together (fig. 3) or arranged in a line along a wall (fig. 4), adapting to the surroundings and the specific situation at the exhibition venue.

Fig. 1. One kinetic object of the sound installation *Echobjects*.

Fig. 2. The kinetic object in listening (left) and playback (right) position.

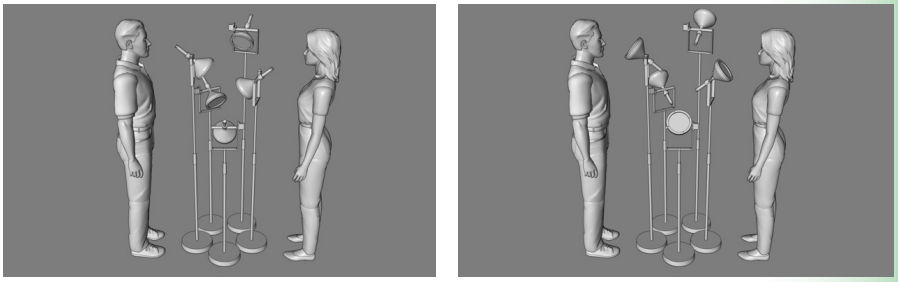

Fig. 3. The kinetic objects in group arrangement, listening (left) and playing back (right).

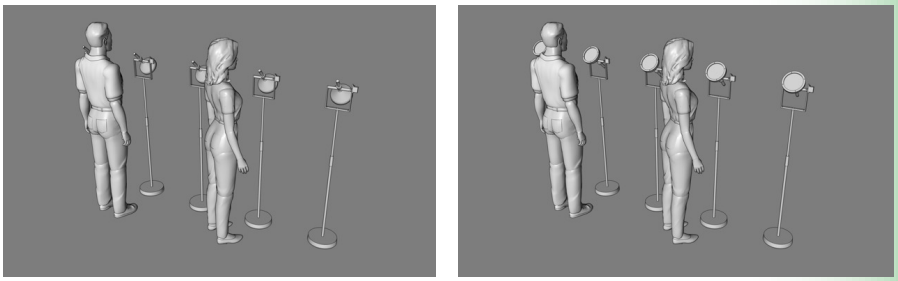

Fig. 4. The kinetic objects in line arrangement, listening (left) and playing back (right).

Audio Processing

During the listening phase, the microphones of the five kinetic objects capture ambient sound, which is then stored in the computer's memory. At the beginning of the playback phase, the most recently recorded sounds are immediately replayed. This echoing of the recorded sounds illustrates the principle of this sound installation, which consists of listening to the environment, memorising the sounds, and playing them back. Gradually, more and more older sounds from memory are re-inserted during the playback phase. The duration of the listening and playback phases varies depending on the acoustic activity of the environment; the more activity detected, the shorter these phases become. The listening phase lasts 10–60 seconds, and the playback phase takes two to five times longer than the listening phase.

The structure of the audio processing is shown in fig. 5. It consists of recording, storing, analysing and preparing sounds for playback. All sound analysis procedures are performed using the FluCoMa toolkit (Tremblay et al. 2022). The audio processing takes place in the following steps. After each listening phase, the computer slices the freshly captured audio based on spectral analysis, starting a new slice whenever there is a significant change in the analysis data (Foote 2000). Those slices whose analysis data prominently diverges from average analysis data are selected and copied to the long-term audio slice memory.

Simultaneously, the audio slice memory is constantly analysed. Older slices that are too similar to newer ones are removed. An automatic clustering algorithm categorises stored slices by spectral similarity. Concurrently, a generative synthesiser produces sounds informed by the analysis data of the recorded sounds. The synthesis process attempts to complement the recorded sounds by generating audio with differing characteristics, aiming to 'fill the gaps' in the analysis statistics of the recorded sounds.

During the playback phase, the audio concatenation engine selects slices from different audio memories to form a continuous audio stream. It uses analysis data, particularly the categorisation into clusters, to select the slices for playback and juxtapose different sound qualities. To ensure variety, the engine randomly chooses different playback modes,

such as mixing, looping, or freezing the slices. The resulting audio output is distributed to the five objects' speakers.

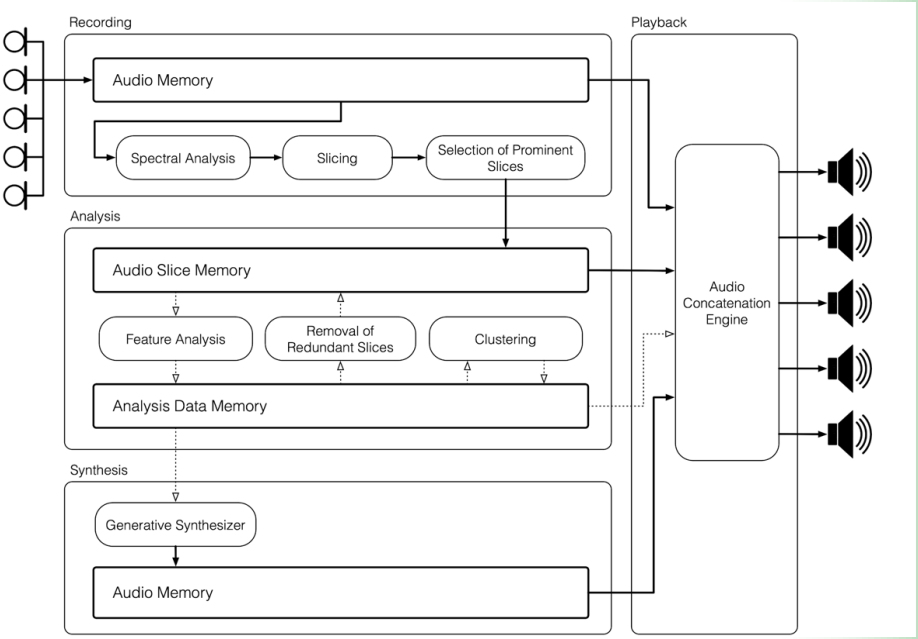

Fig. 5. Flowchart of the audio process (solid lines: audio signals, dashed lines: audio feature data, rectangular shapes: memory buffer, rounded shapes: processing operations).

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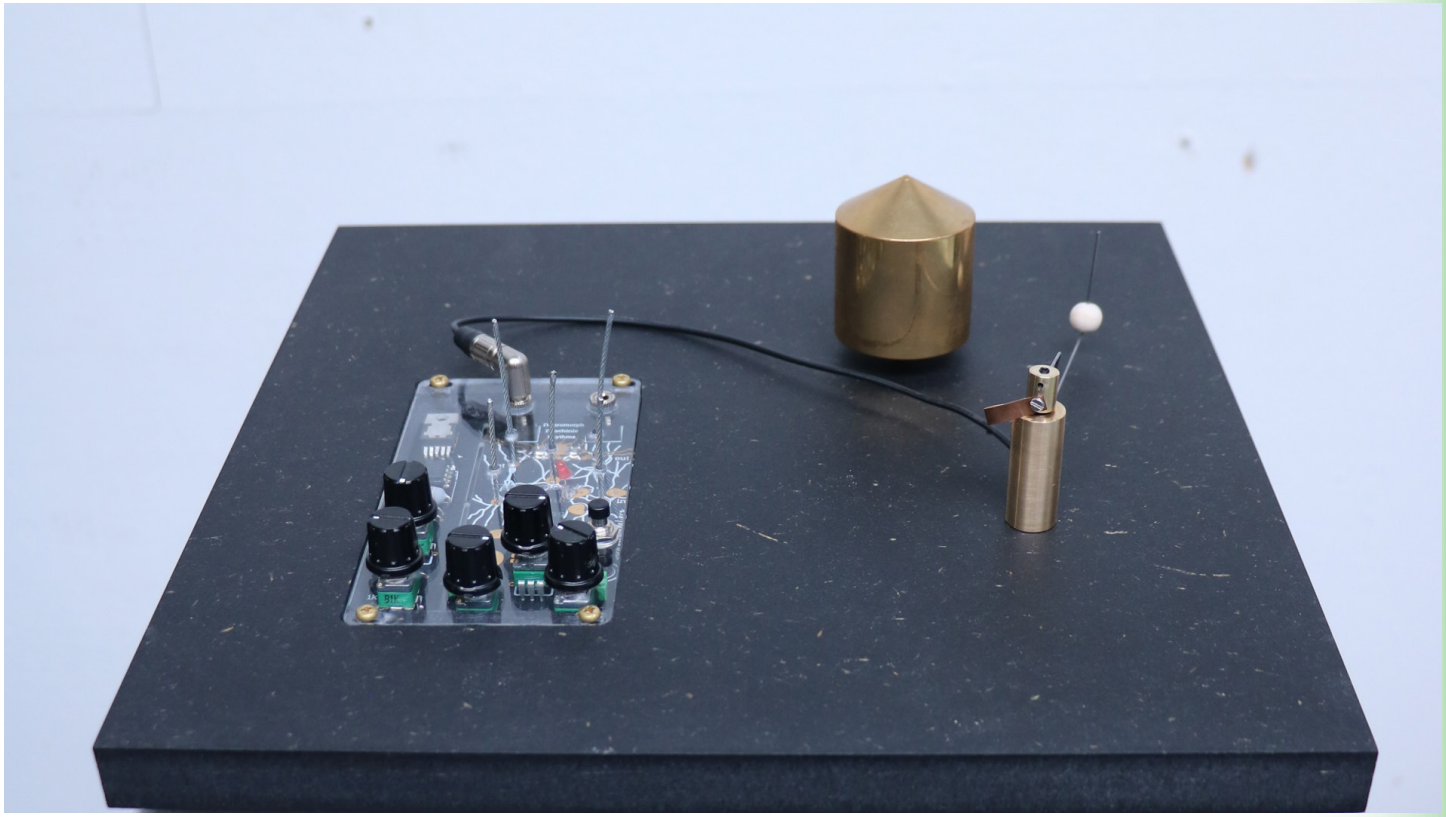
Five Robots Playing Pentatonic, Polyrhythmic Songs: 2-3-4-6-8



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Five robots playing five tuned bells by striking them with a mallet. Each robot is controlled by a minimalist, neurally inspired analogue oscillator. These oscillators are mutually connected and connected to a pacemaker oscillator, and through network connectivity, they will synchronize at different ratios with the pacemaker. Slow-running analog oscillators of the same type switch on and off the connectivity and modulate the activation of the robots' oscillators. Only through these changing network configurations a musical score emerge, that alternates between coordinated polyrhythms, random structure and moments of silence. The complex interaction between the analogue oscillators is visualized with a computer program, that graphically displays the changing relations of the oscillators as multiple x-y plots.

Description

The first documented robots and early automata were mostly self-playing music machines (Stephens and Heffernan 2016; Bruderer 2020). Through complex mechanical clockworks, gears interlocking into each other, these automata drove mallets hitting on bells or hitting on tuning forks (Chen, Ceccarelli, and Yan 2018). Later versions of musical automata encoded sequences of notes to be played on rotating cylinders, discs

Keywords Robotics, Polyrhythm, Analogue Computation, Neuromorph hardware, Sound Installation.
DOI 10.34626/2024_xcoax_034

or punch cards. From that perspective, early musical automata may be considered predecessors for algorithmic computation.

The five robots are in this tradition, but unlike their mechanical and mechanistic predecessors, they are not bound by the rigidity of mechanical connections. They are not bound by the rigidity of digital programming either; unlike the mechanistic and deterministic execution of scripted programs, these robots are controlled by a flexible and elastic network of neurally inspired analogue oscillators. These neuromorph oscillators provide the signals to drive gearbox motors equipped with mallets that hit on tuned RIN-bells (see Fig. 1). The RIN-bells are manufactured by the Japanese instrument maker, Otsuka Factory.

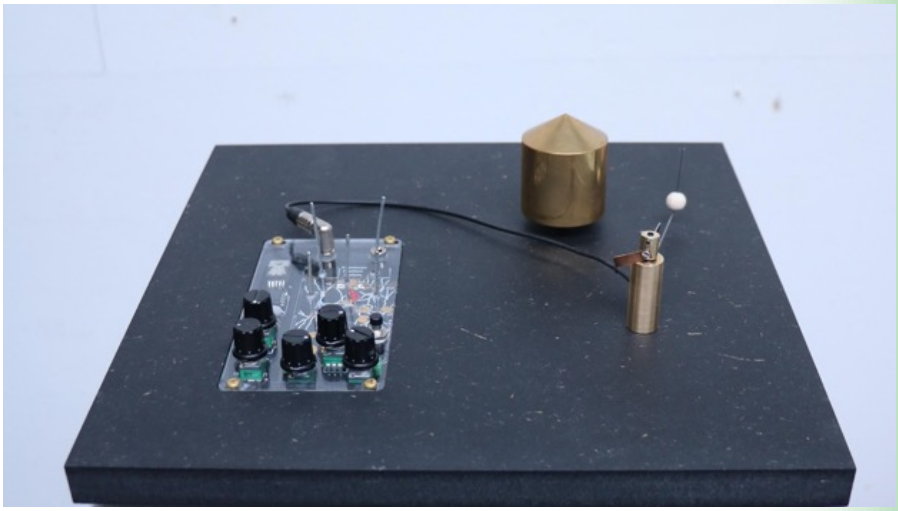

Fig. 1. One of the five robots and an oscillator circuit for hitting on a tuned bell.

Each oscillator by itself produces a beat, and the beat frequency of each oscillator is set by adjusting a variable resistor of a capacitor resistor pair. Rhythmic structures arise when these five oscillators are coupled with a network of variable resistors. In mechanical or digital setups, these structures would be hard-coded into the ratio of different gears or into the sequencing of a digital program. In the analog setup, variations are realized by having oscillators interact at different timescales: those at slower timescales modulate the connectivity of faster oscillators. How such network connectivity of simple neurally inspired oscillators can be used to create polyrhythmic structures is explained in detail in a previous paper (Faubel 2021). Here, exactly the same network topology is used: a central pacemaking oscillator connects to the five oscillators, which are all set to different frequencies, but which match up at different fractions of the pacemaker, when connected. The pacemaker is set to an approximate frequency of 240 beats per minute (bpm), the first robot is set to a frequency of 120 bpm, a fraction of two, the second robot is set to 80 bpm, a fraction of 3, the third is set to 60 bpm a fraction of 4, the forth to 40 bpm, a fraction of 6 and the fifth to 30 bpm a fraction of 8. All settings are only approximate, but when the oscillators are connected, they will go in sync with the pacemaker at the matching ratio, effectively creating the polyrhythm 2-3-4-6-8.

The installation is an adaption and continuation of a work entitled *Network Effect* that has been shown as part of the sound art exhibition *On Air Sound as Material – Material as Sound* at the Art Museum Krefeld (see Fig.2). The installation featured eight tuned bells and a table where visitors could interact with the installation by modifying the network

structure. It also featured a two drawing machines and a projection visualizing the effects of network connectivity.

Fig. 2. Installation view from the previous exhibition *Network Effect* at the Art Museum Krefeld.

For xCoAx I realize a variant that will run fully autonomously without user interactions. Instead of visitors manipulating the network configuration, the installation will modify its own network structure by switching on and off small relays, that are either conducting or not, thus allowing the installation to go from a mode of connectivity where polyrhythmic structures emerge into a mode of disconnect where each robot is just following its own regime. This appearance of structure as an effect of network connectivity will be made visible through a projection of the mutual relations of oscillators driving the five robots (see Fig. 3). In addition to the connectivity, slow-running oscillators also modulate the activation of individual oscillators. A subtle influence modifies the activation of the oscillator; the robot keeps on moving but, under that influence, does not move its mallet far enough to strike the bell. As a matter of fact, sequences of silence are introduced, yet there is never a standstill but always movement within the installation, just periods without bells being stroked. The setup of the installation for xCoAx will be site-specific; the robots may be placed on one or more tables instead of pedestals. The oscillators to modulate activations and network connectivity will not be mounted on a table as in the previous installation, but instead they will be mounted into an eurorack case for modular synthesizers.

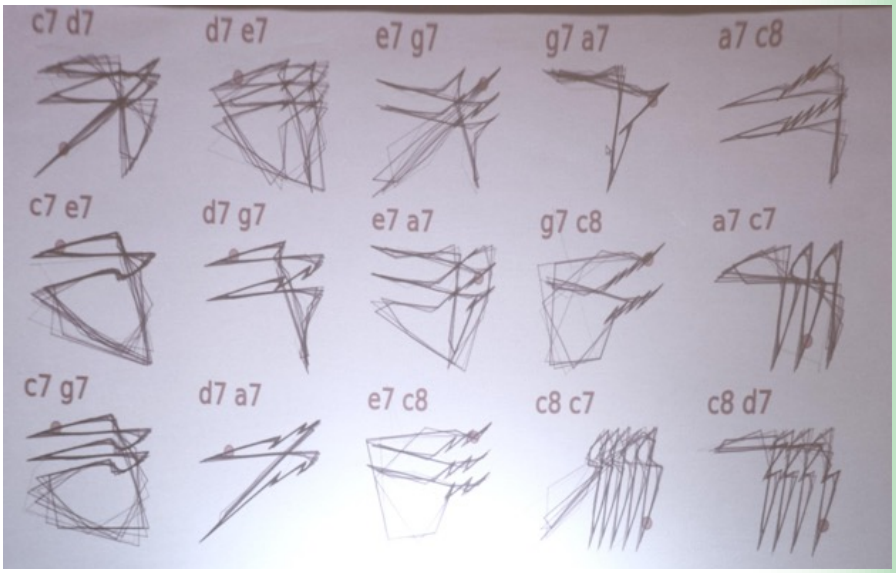

Fig. 3. Network Diagram Schematic.

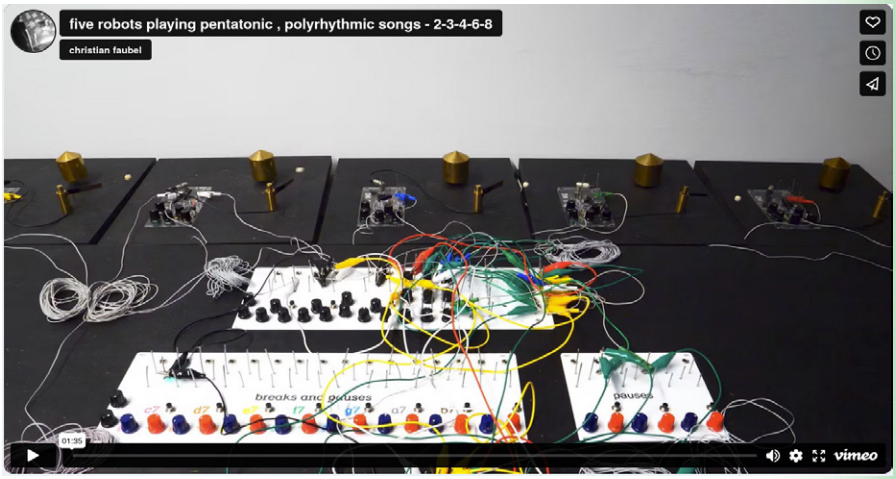

Fig. 4. A video from an experimental setup in the lab (https://vimeo.com/912950719).

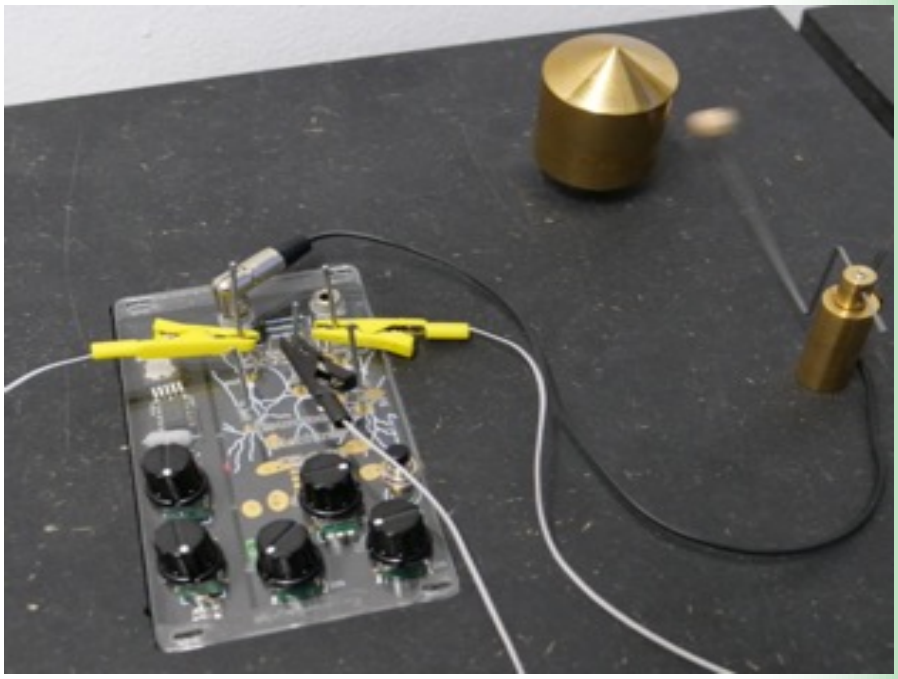

Fig. 5. Two audio examples https://soundcloud.com/fblchrstn/five-robots-playing-pentatonic-polyrhythmic-songs and https://soundcloud.com/fblchrstn/complex-coupling.

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Performances

Lowcore: For Hacked DVD Player

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Lowcore: For Hacked DVD Player is a live electronics performance. The instrument used, is a portable DVD player, subjected to hacking: The pins of the circuit of the DVD player have been extrapolated, so that they can be touched with the skin of the fingers of the performer. The amount of pressure applied with the fingers on the pins and the level of sweating of the hands will change the path of the electrical signal inside the circuit, generating different sound results and different visual interference on the screen of the DVD player (no screen projection of the DVD player is provided). The performance aims to explore the timbral and gestural potential of this hacked object, also subjected to live electronics processes, in an exploratory-performative attitude. The human being, while becoming a portion of circuit and a part of conductor that can close the circuit according to his will, retains its human sweating component. This feature modifies the signal and generates musical gestures on the basis of a totally humanized organicity. The DVD player, assembled and recycled as a new tool, keep the memory of its original functions clear. Once suspended their ordinary functioning, they can be seen under another perspective, acquiring a sound potential that is expressed through contact with the skin of the performer.

Keywords Hardware Hacking, New Instruments for Musical Expression, Residual Instrument, Aesthetics of Error, Residual Sound, Circuit bending.
DOI 10.34626/2024_xcoax_041

Project, process and operation

Lowcore: for hacked DVD player is a live electronics performance. The instrument used, is a portable DVD player, subjected to hacking: The pins of the circuit of the DVD player have been extrapolated, so that they can

be touched with the skin of the fingers of the performer. It is part of a project consisting in a series of sound composition; electronic performances and interactive audiovisual installation called *Not Recyclable Dry Waste*. The project is based on skin conductance response applied on recycled and hacked everyday electronic objects. These electronic instruments are played through the contact of the performer's skin with the circuit of the hacked object, generating complex signal variations. Initially, an analysis is carried out on the electronic components that are in the circuit of the chosen everyday object. The pins (contact points) of these electronic components are extrapolated from the object, so that they can be easily touched with the performer's hands. Depending on how many and which pins are touched by the fingers of the performer, the circuit will be closed differently, generating signal variations. This approach of computation without computer and direct and physical contact by the performer on the components that modify the electrical signal of the instrument highlights a circularity of cause and effect that emerges during the exploration of the system consisting of man-machine. The variables that the performer determines are the "what" is connected and the "how much" is connected. The amount of connection, the "how much", depends on the value of conductivity of the skin at the time of contact and this is strongly conditioned by the performance itself, in the form of sweating, which changes more or less also according to the sensations and thoughts that emerge during the performance. These two variables process the signal and determine the shapes and qualities of the resulting sound. This signal will then be taken into audio, generating a wide variety of complex sounds. Here an example of an Hacked Mouse. Moreover, if the chosen "everyday object" also has a visual part in its apparatus (such as a screen, a projector, a portable dvd player) then the complex variations of the signal will also result visually. See a short example of an hacked DVD player: https://www.youtube.com/shorts/Ji5iEiU4l0U?feature=share. In *Not Recyclable Dry Waste* the research focuses on the timbral and gestural dynamics generated on the signal by the skin conductance response. The conductivity of the skin is modulated according to the level of sweating and the level of pressure when the circuit is touched. In fact, the level of sweating of the skin and the level of pressure applied with the fingers on the contacts (pins), radically changes the way the signal moves in the circuit. In this context the performer acts directly on the configuration of the network of connections with the aim of altering its internal dynamics, generating complex signal variations and bringing out different sound forms. Here an example of an hacked remote controller: https://www.youtube.com/shorts/6bzxiSYOhGk?feature=share. Research can also adapt to interaction with acoustic instruments: *Serracavo: for accordion and hacked DVD player* is the result of this research, born from the collaboration with Carlo Sampaolesi (accordion and electronics): https://youtu.be/rGV6LPuWoqU.

In *Not Recyclable Dry Waste* the objects, assembled and recycled as new tools, keep the memory of their original functions clear. Once suspended their ordinary functioning, they can be seen under another perspective, acquiring a sound potential that is expressed through contact with the skin of the performer. An interesting aspect is how the human being, while becoming a portion of circuit and a part of conductor that can close the circuit according to his will, retains its human sweating

component. This feature modifies the signal and generates musical gestures on the basis of a totally humanized organicity.

Fig. 1. 60° Festival Nuova Consonanza - Mattia Parisse during execution of Lowcore (2023, for hacked DVD player and live electronics. Photo by: Claudia Ciceroni.

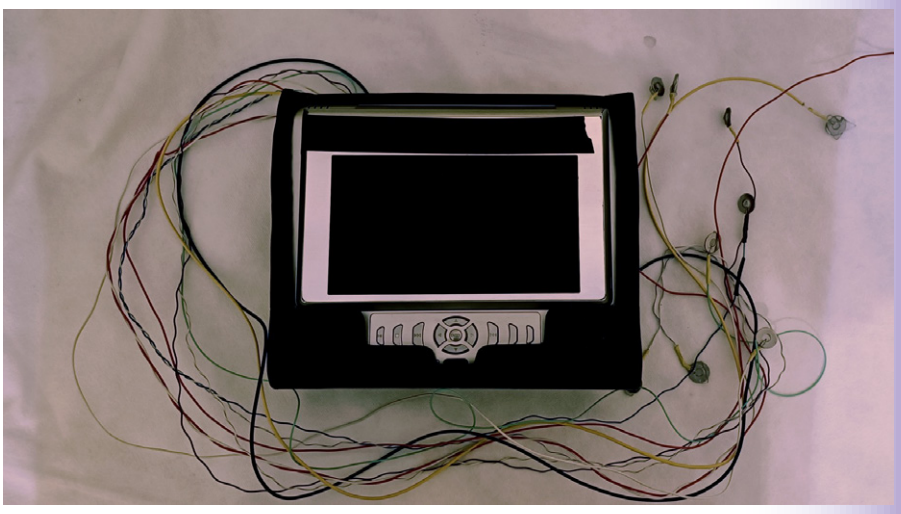
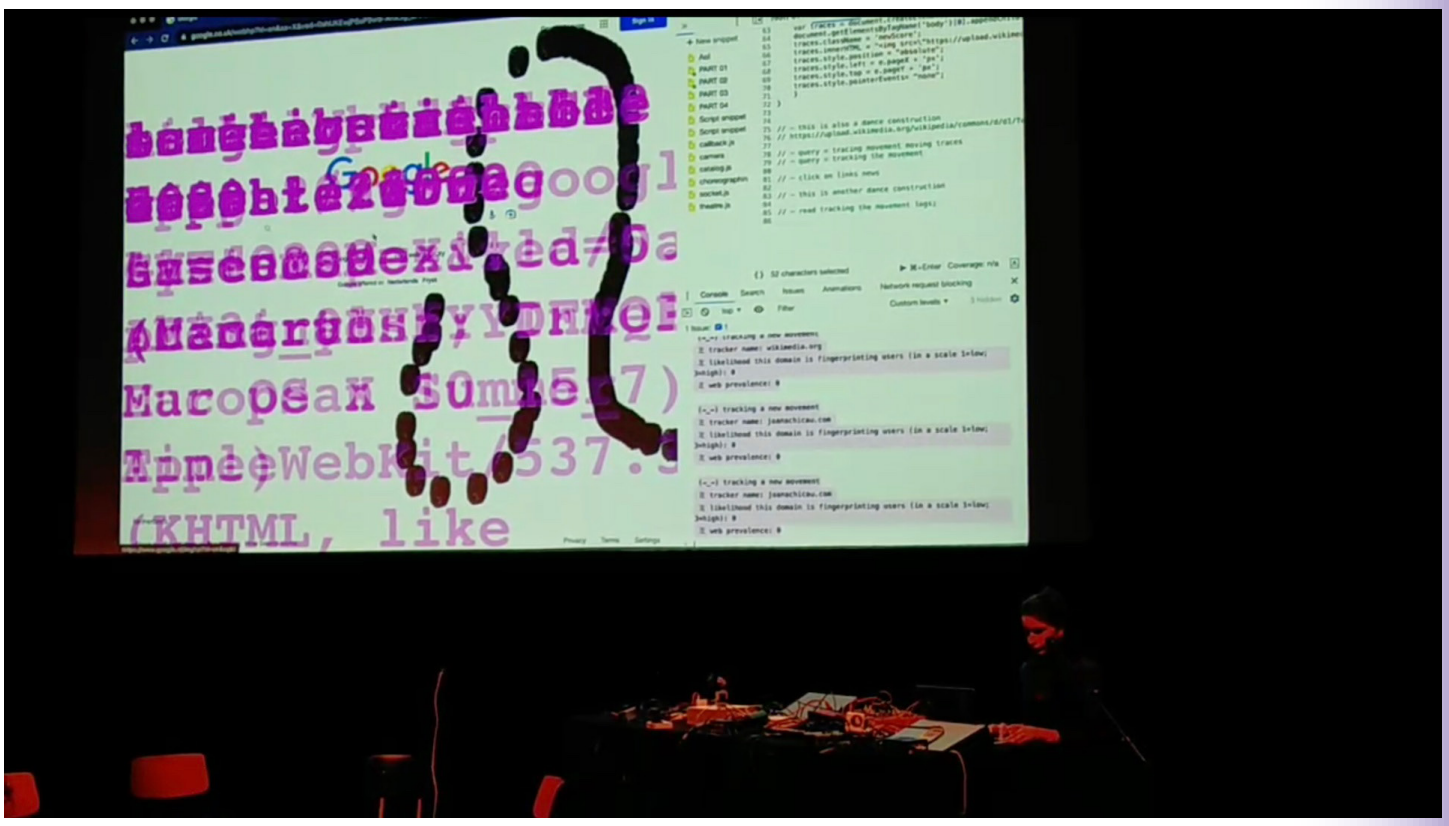


Fig. 2. Hacked DVD Player.

Fig. 3. Hacked Mouse.

Human-Computer Counter-Choreographies



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Human-Computer Counter-Choreographies is a live-coding performance that unveils the algorithms used to track users in web interfaces. The performance combines live coding and the manipulation of JavaScript code snippets, accompanied by voice narration from a choreographic perspective. The performance utilizes a modified version of the Duck Duck Go privacy extension, an open-source tool that monitors online trackers. This ongoing project translates each tracking request into audio and visual feedback. Throughout the performance, the audience is encouraged to participate in a sequence of choreographic prompts, where various aspects of online tracking, such as fingerprinting and profiling, are embodied through physical enactments.

Keywords Live Coding, Embodiment, Choreography, Web Interfaces, Online Tracking Algorithms, Algorithmic Awareness, Algorithmic Transparency.
DOI 10.34626/2024_xcoax_037

Introduction

Algorithmic systems are often made opaque by design, with users being unaware of how much of their data is being gathered (Pold 2019) and for what purposes. Algorithmic systems in society have had various reported instances of causing harm and inequality (Klumbyte, Lücking, and Draude 2020). One example of these are online tracking algorithms which are present in most web services we access today (Kretschmer, Pennekamp, and Wehrle 2021). Surveillance capitalism (Zuboff 2015) has been the driving force of online tracking technologies from early days. The advertising sector is at the forefront collecting

extensive datasets on users' online activities that enable prediction and influence behavior.

The author focuses on the algorithms that are commonly found in everyday web environments, such as the online tracking algorithms described above. Central to this focus is the understanding of embodiment as physical engagement grounded in and emerging out of everyday experience (Dourish 2001). Body-centered approaches provide further understanding of the actions we perform and the computational systems we interact with (Klemmer, Hartmann, and Takayama 2006), which can promote system's transparency. For instance, Experiential AI (Hemment et al. 2019) uses felt experience to make algorithmic mechanisms more understandable. Graspable AI (Ghajargar et al. 2022) proposes the use of physical artefacts and material manifestations as a relational way for understanding and interpreting algorithmic systems.

The proposed performance is part of a practice-based PhD focused on the development of methodologies that comprise embodied and choreographic techniques to inform the design of web-based tools driven by transparency and legibility. It draws from a body of work that explores how choreographic approaches provide alternative insights on how algorithmic systems configure web environments (Chicau 2022).

Regarding choreography, this research practice is highly influenced by André Lepecki's writings on choreography as a control mechanism and the need to question how we can assert our freedom of movement and agency in societies that are intricately, even if subtly, controlled (Martin 2015). Another influence is the theatre practitioner Augusto Boal, known for the method Theatre of the Oppressed (Teatro do Oprimido) developed in the 80's. Boal understood theatre as a rehearsal for eve-ryday life, not an end in of itself but the beginning of social transformation that supported the de-alienation of the body and mind towards disrupting the repetitiveness of daily tasks (Boal, 2019). American choreographer Yvonne Rainer who took inspiration from observing individual pedestrians and crowds in the streets of New York City. She would transpose the movement observed from the streets into the theatre and opened new possibilities for performing the self and sociability (Wood, 2007). While Boal focused on class struggle and justice and Rainer in feminism and identity politics, both turned the theatre inside out and believed in the transformative potential of performance in real life.

Embodied methods and choreographic approaches are used to guide this research practice and provide new insights for designing web environments with the goal of empowering its end users. Its aim is to question and challenge the opaque algorithmic models prevalent in surveillance capitalism and advocate for algorithmic transparency and legibility.

Performance Description

Human-Computer Counter-Choreographies is a live-coding performance that exposes user-tracking algorithms in web interfaces. The performance interweaves live coding and manipulation of JavaScript snippets with voice narration, choreography and physical enactments. This performance uses a custom version of the open-source Duck Duck Go privacy extension that tracks online trackers. This tool has been

changed to map each tracking request to audio and visual feedback. Additional custom web programming scripts are used and modified throughout the performance to draw the audience's attention to different aspects of online tracking, such as fingerprinting.

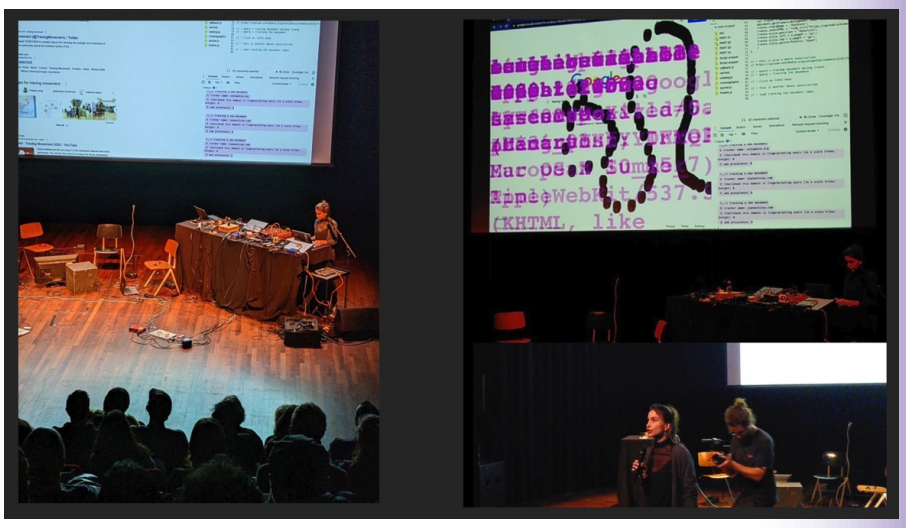

Fig.1 Audience view of the performance *Human-Computer Counter-Choreographies* (Beta) by Joana Chicau. Photographs by Creative Coding Utrecht (left) and Ulysses Popple (right) at the International Conference for Live Coding (ICLC 2023).

As shown in figure 1, during the performance a browser window is projected in the performance space. The window is divided in two: on one side it displays the websites being navigated and on the other side the web developer tools. The latter shows the programming scripts written for the performance that are altered and called at given times. The web console also shows message logs with information on the various online trackers that accumulate as the performance unfolds.

The programming functions created for this performance are named after choreographic concepts. This practice of adding syntax and meaning to the standard syntax of functional or procedural programming is referred to as Esoteric Programming (Temkin 2022). In addition to the choreographic concepts, comments have been added between lines of code to explain or highlight different parts and help the audience follow through the narrative. The code that follows presents snippets from different parts of the performance to exemplify the aspects above:

```
// user's browser and device data commonly used in fingerprinting
datapoints= setInterval(accumulation, 200);
// prompts inspired by user metrics used in web analytics
audience.innerHTML= 'please STAND UP if your age: 25 to 34';
// another dance construction: cursor tracking
window.addEventListener('mousemove', moving, false);
```

The text after the forward slashes '//' display comments which are not run by the computer but are used to introduce each line of code that follow, with functions named after choreographic concepts.

While code is being triggered and the interface modified, the author invites the audience to engage with choreographic prompts that introduce aspects of online tracking, such as fingerprinting and profiling through a series of physical enactments. These same prompts

are embedded in the code and overlayed on the webpage for the audience to read.

To differentiate the custom code functionalities and overlaid text in the interface, a pink color theme (hex code #af3eff) is used to style these. As shown in figure 1, the tracking logs are listed with pink background in the webconsole and the text added to the webpages uses the same color value. In addition, a flashing pink background animation accompanies the sound of a metronome triggered by each tracking request.

The voice of the performer present throughout the piece, plays an important role in connecting the different elements of the performance: from the algorithms to the bodies – tying them in a fluid narrative.

By intersecting the tools described above with embodiment, choreography and improvisational approaches from live-coding practices, this performance invites participants to reflect upon, engage with and challenge user-interface paradigms.

Related Work

Various organisations have been working on software products that enhance user privacy when browsing the web. Examples include the already mentioned work by Duck Duck Go and the Tor browser (2006) that provides crypto-based privacy-enhancing technologies (PETs). Still on the industry side, London-based studio Normally created Cabin (2020), a privacy-first and carbon-conscious web analytics tool. Unlike most web analytics tools it does not use cookies nor shares data with third parties or ad networks.

To empower communities and individuals to become more resilient in their digital presences, Tactical Tech, a non-profit and non-governmental organisation, has been creating and distributing educational resources. One example is The Data Detox Kit (2016), a toolkit that provides step-by-step guidance in reducing one's online traces.
Artists and technologists have also been responding to concerns about online algorithmic surveillance with various artworks and tools. Examples include the piece Listening Back (Guffond 2023) an add-on for the Chrome and Firefox browsers that maps internet cookies to different sounds, creating a melody while browsing. The GoogleTeller (Hubert 2022) a tool that makes audible each packet or tracker request sent to a Google service. The plug-in Safebook (Grosser 2019) which removes all content from Facebook leaving the interface as an empty grid of white, gray and blue circles and squares. The same artist created Demetricator (Grosser 2017) which removes all the metrics from the Twitter feed. Both interventions question the quantifying nature and anxiety-inducing character of these platforms.

Dance performance and choreography have also been adopted as a way of critically engaging with technological apparatus. One example is the initiative Cryptodance (2016) that hosts events with the intent to collectively reflect on issues of privacy, safety and surveillance through embodiment and dance. Another example is the artwork Score for Performing User (Lee McCarthy 2022), a series of instructions-based exercises that invite users to reflect on their identities and question issues around privacy, ethics, and justice in online environments.

In the live-coding scene, various authors have been exploring the integration of embodiment, dance and choreography. Kate Sicchio researches the intersection of code and choreography through both choreographic devices and programming languages, which can be seen in work such as Hacking Cho-reography (2012). More recently, in Codes for a Dance (Sicchio and McLean 2023) the authors interact with two robots on stage through a series of gestures that influence the soundscape. Marije Balmaan's work has also explored the use of gestures, such as The Machine is Learning (2021) a theatrical piece whereby a machine is trained to detect gestures being performed yet it repeatedly fails to do so accurately.

To add another recent example, the live-coding environment CO/DA captures the motion data from dancers and can be programmed to generate audio feedback on-the-fly (Françoise, Fdili Alaoui, and Candau 2022). To add to the diversity of approaches, the research project MosAIck (Wilson, Elizabeth et al. 2023) connects live-coding practices with dance mediated through e-textile sensors.

While not a comprehensive review, the references above provide pointers that help situate this research within browser-based, net art, tactical media, dance, choreography and live-coding. The work proposed herein is the first to explore the intersection of these areas of practice.

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The Sonic Conductor

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The sonic baton is an intelligent instrument with significant sonic possibilities and has the potential to expand the practice of the iconic role of the conductor. *The Sonic Conductor* uses the sonic baton to lead an ensemble, while the sonic baton translates and sonifies the conductors' movements and gestures making the conductor an audible member of the ensemble. Through a series of graphic scores that use different notations under different performance contexts, the experimental performances explore subversions, extensions, and expansions of conducting practice aiming to test the ultimate boundary – at what point does the conductor lose their iconic role through expanded practice and the sonic baton simply becomes a sound stick?

Keywords Sonic Baton, Intelligent Instrument, Gesture Performance, Communication, Experimental Music, Graphic Score, Neural Audio Synthesis.
DOI 10.34626/2024_xcoax_038

Background

Traditional conducting practice and historical chironomy in music is well studied. Technologies applied in musical performance and composition are already proving to have impacts on artistic expression and musical collaboration across multiple genres and instruments for many decades, however those technologies have mainly been devised to control and edit sound rather than integrate it into the musical setting. More recently, there has been considerable complementary research and creative contribution through New Interfaces in Musical Expression (NIME) with new instrumental development, such as the *Halldor-*

ophone (see Úlfarsson and Magnusson 2023; Úlfarsson 2018), the *Proto-langspil*)see Armitage et al. 2022) and the *Overtone Fiddle* (Overholt 2011) to name a few. Scoring tools and softwares such as *Decibel ScorePlayer* (Hope and Vickery 2015) and The BabelBox (Bell et al. 2019), alternative notations such as The *Magnetic Score* (Privato et al. 2023), and new performance formats, such as *Scoring an Animated Notation Opera* (Hope et al. 2018) and *AI Brainwave Opera* (Pearlman 2022) also create a momentum around NIME and the impact technology in music is having on performance and composition. These developments in artistic research over the past decade point to the relevance and timeliness of exploring a space for expanded conducting practice using music technology, that can potentially contribute to artistic practice, scholarship, and the broader musical community with the utilization of technologies in artistic and musical outcomes.

The significance of the performances described opens the practice of conducting and gesture performance to explore how technology can pioneer new artistic possibilities for not just conductors, but composers, ensembles, and more broadly, larger live music productions and their audiences. Currently there is limited research and media on expanded conducting practice and its impacts, especially with a focus on an integrated role of technology within musical creativity. History does inform us however, that conducting practice and its musical possibilities, does expand with each industrial revolution.

Technology

Several sonic conducting batons were built at the same time and contained either an accelerometer sensor or a gyroscope sensor placed on the batons by Sean Patrick O'Brien from the Intelligent Instruments Lab at Iceland University of the Arts. The sensors produced an Arduino signal to a Max patch via a wireless router. Several Max Patches were made by Nicola Privato from the Intelligent Instruments Lab sourcing sound data with a choice from either sea mammals, an electric guitar, or a human voice. These sonic datasets were prepared by Victor Shepardson and researchers at the Intelligent Instruments Lab at Iceland University of the Arts. Each set of sounds was used to train a Realtime Audio Variational autoEncoder (RAVE) following (Caillon and Esling 2021). Acceleration gestures from the batons were mapped to vectors in the learned latent space via an accelerometer sensor, and the RAVE decoder was used to convert the stream of acceleration values into a stream of audio as presented in the sonic baton case study (Armitage, Privato, Shepardson, Gutierrez 2023). This resulted in the spatialization of sound within the latent space that can be used to explore and navigate the RAVE model, thus giving the conductor a degree of agency in performance with the sonic baton.

Performances

Realizing the expanded sonic possibilities, I (Majella Clarke), a conductor, worked alongside several composers to develop new notations and scoring to integrate the sonic baton into different ensemble set-ups. *May The Whole Universe*, the composition by composer Bergthora Ægisdóttir is a graphic and text score for open ensemble, see Figure 1. The com-

position opens with the statement “May the whole universe, in relation to my body, be to me, what to a blind man his stick is in relation to his hand. His sensitivity is no longer really in his hand but at the end of the stick. May the whole universe become like a second body to me”, from Simone Weil’s book Gravity and Grace (Weil 2002, 140).

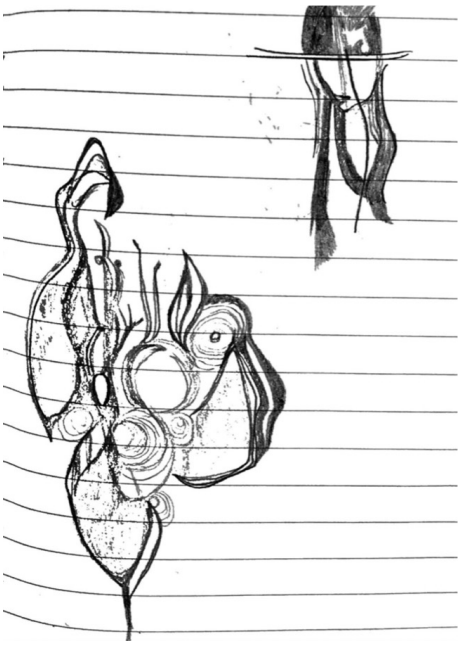

Fig. 1. May The Whole Universe by Bergthora Ægisdóttir.

The composer’s method of scoring was to enter a lucid surrender to the universe with subconscience spontanous drawing reflecting the artists’ inner sense of time and space. The composition has been performed in several different ensemble set-ups with the sonic batons. The first set up uses only conductors with their sonic batons, eliminating the conventions conductor-performer hierarchy, and subverting the ensemble to include only multiple sonic leaders, see Figure 2. But can everyone be a conductor in an ensemble? And is one conductor more dominant than the others? What makes a dominant conductor? Is it gesture, presence, or the baton’s sonic possibilities? The performance challenges the audience to explore these questions as they watch the three conductors with three sonic batons in performance as a sonic trio of conductors facing each other drawing gestural inspiration from the graphic score.

Fig. 2. Video Asset: https://www.youtube.com/watch?v=4puHR0G6qdI.

The second setup performed *May The Whole Universe* and included an ensemble with acoustic instruments and vocalists improvising, alongside a conductor with a sonic baton, see Figure 3. This rendition of the composition is completely different, and the performers not only draw musical improvisation from the graphic score, but also from the sonic conductor's gestures. Do the conducting gestures inspire ensemble unity and/or creativity while working with a sonic baton? Or is it just a sound stick where the conductor becomes a performing member of the ensemble?

Fig. 3. Video Asset: https://www.youtube.com/watch?v=WIy0IHiTMM4&t=5s.

In these performances of the same composition, we see two very different styles of conducting, the first is a subversion of the practice of conducting, with all batons on equal role and sonic responsibility in the performance. The gestures of the three performers are experimental as they explore their sonic capabilities facing inward towards each other, listening, and responding to each other's sonic colors and gestures. The second performance depicts the use of the sonic baton in a traditional conducting context. It integrates the intelligent instrument into the ensemble, but also using the sonic baton to provide gestural communication and coordination with the ensemble.

The next composition is *Through Stillness I Found Death* by Juan David Bermúdez for string ensemble and sonic baton. The composition utilizes both standard musical notation and graphic notation on four pages of soft off-white translucent papers representing the stratification processes studied by geologists, see Figure 4.

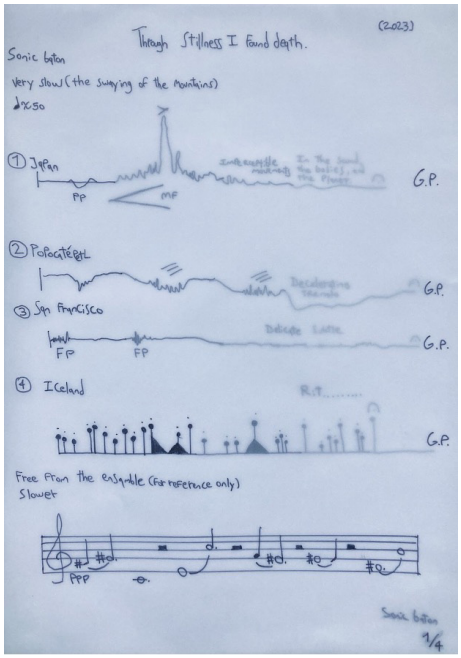

Fig. 4. *Through Stillness I Found Death* by Juan David Bermúdez for string ensemble and sonic baton, excerpt from the sonic baton score.

The sonic baton's notation is based on earthquake data from different parts of the world, while the string ensemble reads notation with some graphic notation to communicate the effect of the scored sound. While the string orchestra has both musical and graphic notation, it is not continuous. More precisely, the composition is modular, and there is also a series of improvising elements to the composition, which means that the players can take gestural direction from the sonic conductor or they can choose not to. What is perhaps important to note is that the left hand without the baton is necessary to direct the ensemble gesturing cues when necessary, and indicating the conclusion of each module, see video asset link under Figure 5.

Fig. 5. Video Asset: https://www.youtube.com/watch?v=rPACyw0rioU.

Concluding Remarks

The exploration of the above performances is expected to present insights and inspirations into technology in music, while providing new awareness for conductors, composers, and performers into the possibilities of experimenting with intelligent instruments and hybrid ensembles that use both intelligent and acoustic instruments. For hybrid ensembles, modular compositions applying both graphic and music notations provide ample opportunity to experiment with new sounds through conducting gestures. The performances demonstrate that conducting practice expands with the use of technology in the form of neural audio synthesis. The expected outcome of the performances and use of the sonic baton intends to invigorate new compositional methods and notations, further develop sonic possibilities within the intelligent-acoustic hybrid ensemble formulation and expand the practice of conducting.

Acknowledgements: Three personnel of the Intelligent Instruments Lab at Iceland University of the Arts, Iceland, were part of the team that collaborated in the development of the sonic baton and performance demo. Nicola Privato provided technical expertise in the set-up using Max MSP, Victor Shepard produced sound files with RAV models with PyTorch and Sean Patrick O'brien placed the sensors and batteries on the baton. Nicola and Victor were also part of the performance demonstration at the Towards Sound Finissage at the Living Art Museum in Reykjkavik. In addition, Dr Jack Armitage was a sonic baton conductor in the performance of *Through Stillness I Found Death* by Juan David Bermúdez.

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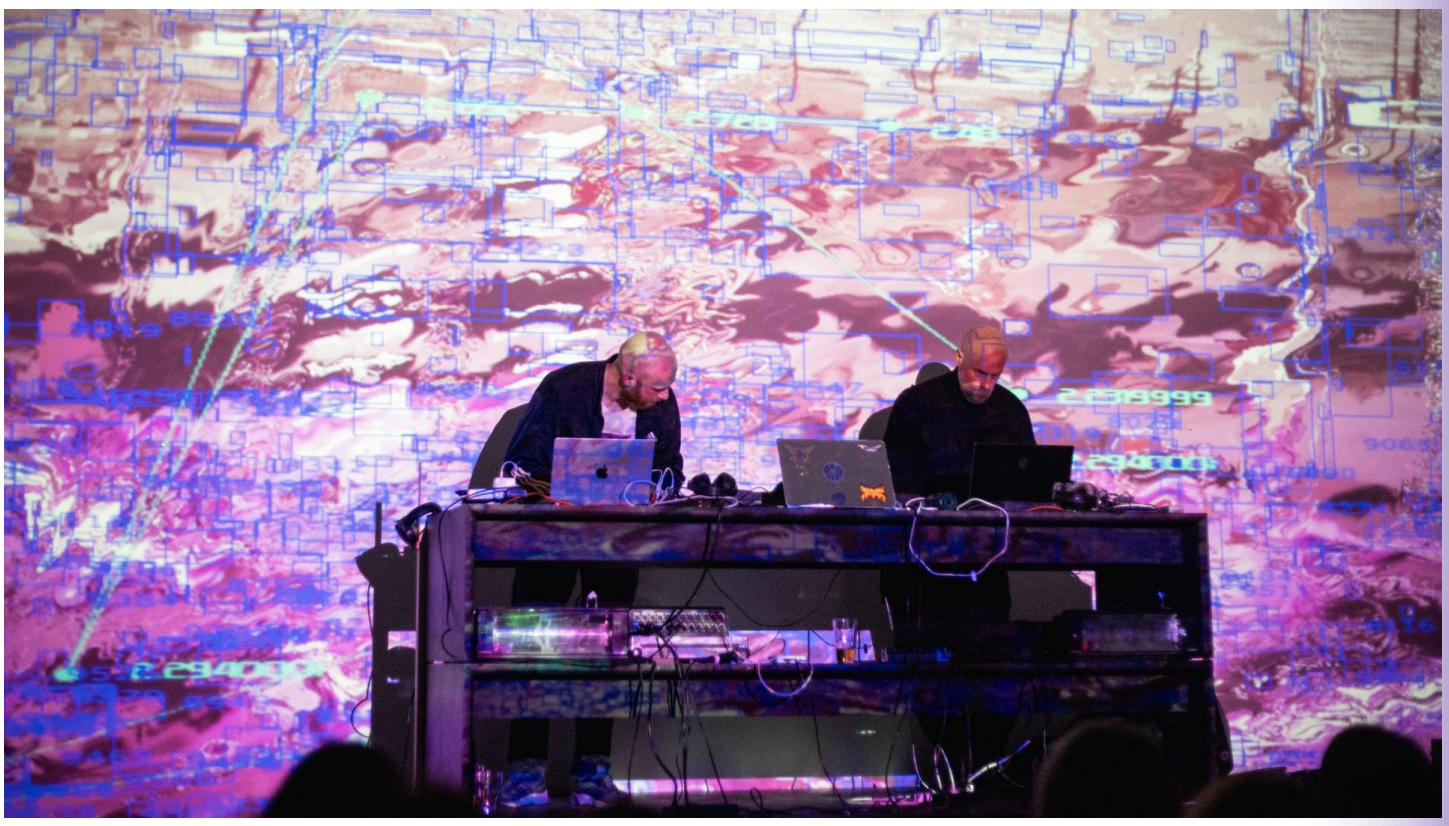
TuringGaia: Composing the ((Non)Human)



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TuringGaia: Composing the ((Non)Human) is an audio-visual performance that explores ((Non)Human) agency through an AI-driven NPC within a virtual ecosystem. Central to this exploration is NPC-Markov, equipped with an advanced cognitive architecture that intertwines algorithmic interactions with environmental affordances, creating a complex audio-visual narrative on artificial agency and environmental engagement. The performance connects to an NPC in a Gaming Engine (UE5). The NPC operates in a zero-player game as entropy mitigator of a virtual world under siege of a chaotic climate, offering a metaphorical take on survival tactics amidst the climate crisis, highlighting themes of adaptation and resilience. A Large Language Model (Inworld), acting as a meta-narrator, deepens this narrative, expressing NPC-Markov's explorations and reflections through a synthetic voice (Elevenlabs). By blending the footage generated by NPC-Markov with advanced audio techniques, *Composing the ((Non) Human)* crafts a dynamic narrative that evolves in real-time, showcasing the fusion of digital storytelling, gaming environments and soundscapes.

Keywords Cyber-Physical Ecosystem, Computational Aesthetics, LLM, NPC, Cognitive Architecture.
DOI 10.34626/2024_xcoax_042

Description

TuringGaia: Composing the ((Non)Human) is part of the umbrella research project TuringGaia | Entering ThermoDome on display during Meta.Morf 2024 (NO). The research project investigates the intricacies of how an autonomous non-playable character (NPC) embedded in a virtual ecological zero-player game can narrate and communicate its environmental journey and internal 'experience'. The long-term installation serves as a sandbox, where every day NPC-Markov faces not only a different climate, it also collects data, such as pixel-based entropy, temperature, color variation, location-based events, perceived objects, etc.

The title *TuringGaia*, refers to an increasingly developing scenario where the biosphere and technosphere have reached a profound state of symbiotic interdependence. In this scenario the technosphere, or The Stack (Bratton 2016) contributes to Earth's self-regulation alongside the biosphere. This integration fosters possibly a heightened planetary awareness, presenting both ecological challenges and opportunities as humanity plays a central role in shaping the coevolution of biology and technology on our planet. The ((Non)Human) encapsulated by its double parentheses, functions as the new subject of this new hyperconnected constellation, which ultimately provokes us to rethink an obsolete notion of Nature (Latour 2017).

Composing the ((Non)Human) unfolds as the live demonstration of TuringGaia as a Cyber Physical Ecosystem (Friston et al. 2022), where humans and AI interact to facilitate a 'shared intelligence', and in our case exploring the artistic limits of ((Non)Human) agency. The performance carefully navigates the boundaries between human and non-human elements through AI, sound, and image. Central to this exploration is NPC-Markov, an advanced cognitive architecture equipped with a distinctive sensory suite. The base architecture consists of a range of finite state machines inspired on the subsumption architecture (Brooks 1986). These are behavioral based states and diverge from exploring, interaction, exploitation, focus, manipulation, etc.

Positioned within a carefully designed virtual realm, NPC-Markov's interactions are influenced by a dual approach: on one hand, they are shaped by procedural algorithms, memory processes, and environmental inputs; on the other, they are delicately guided and adjusted through the parametric manipulation of external variables. This dual approach facilitates a refined engagement with and modulation of NPC-Markov's behavior, enriching the resultant audio-visual composition.

Equipped with sensors, sensitively calibrated to measure digital entropy, and thermal variations, NPC-Markov harnesses environmental heat as a pivotal element in crafting the live performance. This sensitivity plays a pivotal role in the live composition process, where heat — as an experimental narrative and auditory guide — is harnessed from the environment. This innovative approach not only allows for dynamic responses to subtle thermal changes but also metaphorically explores survival strategies in an era of climate crisis, presenting a thought-provoking commentary on adaptation and resilience. However, this introduces a challenge: how can we make NPC-Markov's experiential world not just perceptible but also meaningful and relatable to a human audience?

To explore this question further, the creators employ a Large Language Model (Inworld) as an interface for ((Non)Human) interaction. Inworld serves a dual purpose: it acts as a meta-narrator —expressed as a synthetic voice— articulating NPC-Markov's environmental explorations, and it also offers introspective reflections on NPC-Markov's internal states, which are informed by the NPC's cognitive architecture. This is by no means aimed at further mystifying the computational processes, but rather seeks to cultivate a creative dialogue with NPCs as an emerging class of Autonomous Language Agents (Weng 2023; Wang 2023). Additionally, Large Language Models (LLMs) are proposed as tools for enhancing a general game sense for promising actions conditioned on game history (Yao 2020). This methodology enables the NPC to more effectively engage with its surroundings, thus facilitating a deeper investigation into the capabilities and potential of LLMs as interfacing ((Non)Human) experience.

The performance and its technical back-end emerge as extension of Cybertext (Aarseth 1998), crafting a story that speaks to the resilience and adaptability inherent in life. Within this digital ecosystem, NPC-Markov adjusts to shifting climatic conditions against a backdrop of unpredictable weather phenomena, ecological uncertainties and surprising flora and fauna. This virtual setting acts not only as a narrative canvas but also as an aesthetic document to survival, offering a rich and imaginative examination of a world in active dialogue with the impacts of climate change.

Integrating live interaction with the NPC, the performance invites NPC-Markov on an autonomous voyage through a complex digital realm that unfolds in real-time. This approach engenders an organic narrative and a cohesive composition that evolve based on the game's decision-making processes. Such interactivity adds a compelling layer of complexity, with each decision subtly influencing the narrative's progression and the soundscape's evolution. This dynamic interplay exemplifies the potential of algorithmic composition to elevate sound beyond a supportive role, transforming it into an essential, interactive component of the story.

The creators assume the role of dynamic live orchestrators, shaping the environment visually and sonically, where digital and live performance seamlessly converge. In this liminal space, the NPC reacts in real-time to human performance. Meanwhile, the human performers attune to and interact with the NPC's 'experiences', fostering a reciprocal feedback loop of the ((Non)Human). The performance fluidly alternates between spontaneously generated content and structured compositions, constantly wavering between a quasi-theatrical presentation and an immersive live concert.

The composition integrates two key tools, blending real-time and pre-processed elements. It employs the Ircam Acids Real-time Audio Variational Autoencoder (RAVE) (Cailon and Esling 2021) to link live audio with vast sound databases through timbral and temporal similarities, tapping into a deep reservoir of abstract sound memories. Additionally, it utilizes the University of Huddersfield's Fluid Corpus Manipulation (FluCoMa) toolkit (Tremblay, Roma and Green 2022) for breaking down and speculatively separating sonic elements. This approach fosters a synthetic form of listening, marked by artifacts and misinterpretations, producing a stream of evolving sound objects that

mimic continuous cognitive associations between the external and internal realms. Together, these tools not only enhance the composition's auditory depth but also underscore the intricate relationship between pre-processed and live elements, all while maintaining a seamless integration with the overarching themes of the ((Non)Human) and its (techno) umwelt (Uexküll 2013).

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Transmutation: Für Holz und Silizium

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Transmutation: Für Holz und Silizium is a multi-channel musical performance that blends the acoustic sounds of a traditional Ghanaian balafon with digital sound processing via SuperCollider. Developed over one and a half years, this piece reflects an engagement with both electronic and acoustic musical forms. The performance initiates with a single strike on the balafon, which is then digitally captured and processed to generate diverse sound textures and structures, including polyrhythmic, tonal, and atonal elements. This transformation involves several custom-developed SuperCollider modules that manipulate the sound through techniques such as feedback delays, chord modulation, Shepard tones, and multi-channel delays. The process culminates in a cyclical return to the original sound. The performance explores the broader theme of transmutation, bridging the gap between analog traditions and digital innovation in a live improvisational setting.

Keywords Minimal Music, Electro-acoustic, Balafon, SuperCollider, Transmutation, Improvisation.
DOI 10.34626/2024_xcoax_044

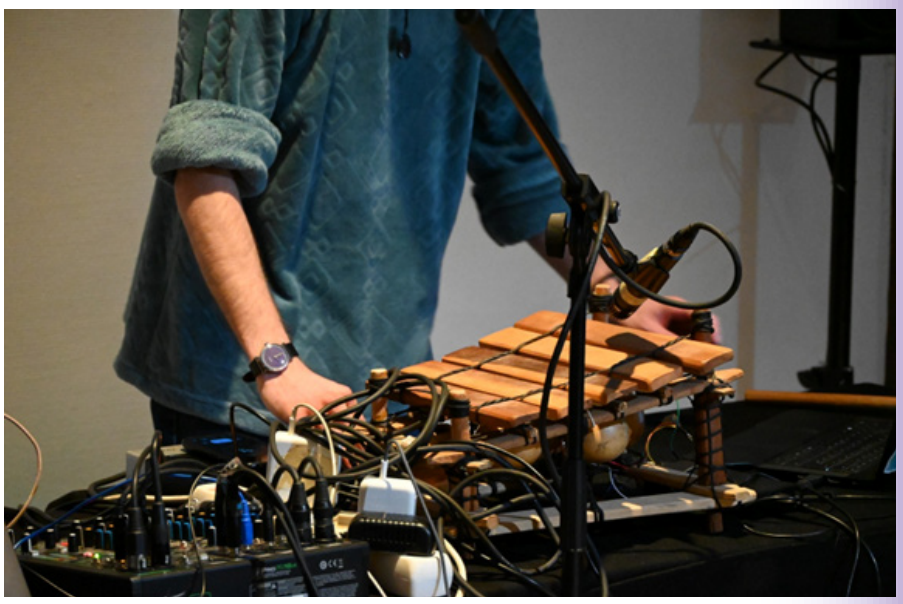

Fig. 1. Photo of the performance at *Errant Sound*, Berlin.

Transmutation: Für Holz und Silizium

The performance *Transmutation: Für Holz und Silizium* (Transmutation: For Wood and Silicon) is a multi-channel musical composition with improvisational elements. A Ghanaian balafon serves as the sound material and self-developed algorithms in SuperCollider as the sound processor. By recording a single hit of the balafon at the beginning of the performance, this material is transformed and altered in real time into polyrhythmic, tonal and atonal soundscapes.

Background & Idea

The performance was developed over a period of one and a half years and reflects my relation to electronical and acoustic instruments and media. During my residency at pIAR (perforcrazy International Artistic Residency) in Kumasi, Ghana, 2022, I started experimenting with a five-wood pentatonic balafon that I bought at the local market. At that time, I was particularly interested in experimenting with analog and electronic sound sources combined. But I was also torn between the use of technological media and the acoustic use of instruments, which was very prevalent in Ghana. So, I began to modify the balafon and incorporate it into my artistic practice. Coming from a jazz guitar background, it was important to me to develop an environment that would process everything live and leave room for improvisation.

I decided to start the performance with only one hit of the balafon, which serves as the sound material. This material is then transformed by the technology into all kinds of materials. At the end, it returns to its original form, still sampled. Although the sound is the same, the perception of it is very different due to the experience of the performance.

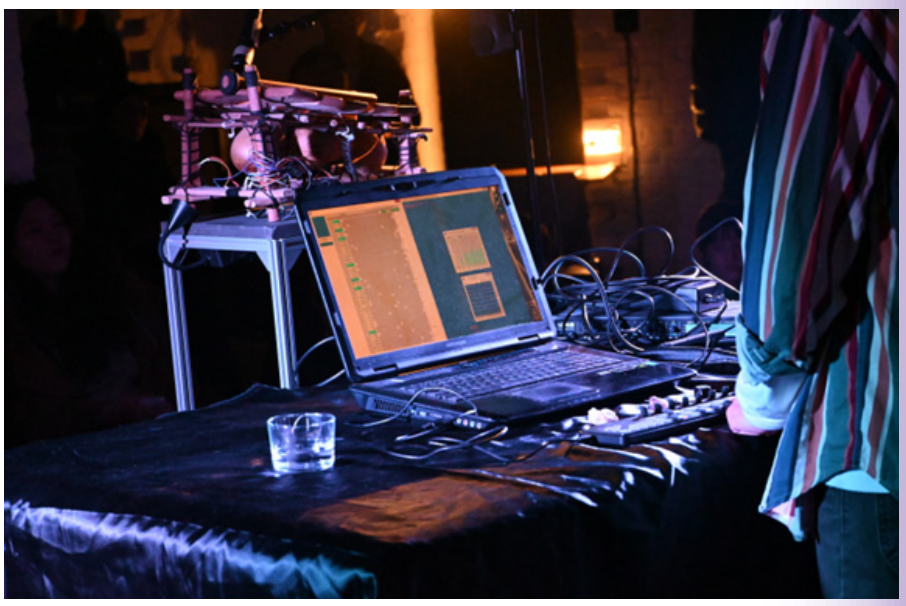

Fig. 2. Photo of the performance at *SOMA ART*, Berlin.

Technical & Artistical realization

Technically, the Belafon serves as the sound source, captured by an SM57 dynamic microphone. It is fed into SuperCollider via the audio interface. Within SuperCollider, the sound is processed by several modules I developed. Besides some extra channels for sub-bass processing, the sound passes through the following modules:

Simple Feedback is just a feedback delay that acts as a looper to initialize the performance.

ChordBuffer captures the sound coming from the feedback delay and channels it into a ring buffer that is read by four headers at different playback rates. These four different playback rates form a four-tone chord. The chord changes periodically, but the selection of the chord is random. There are three chords in five different voicings. The chords are I maj7, II maj7, and V maj7. Harmonization by playback rate modulation instead of pitch shifting not only provides a cleaner sound, but also creates polyrhythmic structures in the respective harmonic relations. Parameters such as tone density, glide between playback rate modulations, and overall pitch control define the sound.

Shepard Buffer is inspired by the Shepard-Risset Glissando, discovered by psychologist Roger Shepard. It gives the impression of a continuously rising or falling pitch, in this case a falling pitch. Five ring buffers record the incoming sound in five different octaves. To achieve the falling pitch, the playback rates are modulated by half, with the highest buffer fading in and the lowest buffer fading out.

Cybernetic Feedback is a self-modulating multi-channel delay. The feedback signal is directly modulating the delay time, slowly crushing the sound into noise-like soundscapes.

Octopus is inspired by elef@nt, developed by Prof. Dr. Alberto de Campo and Hannes Hoelzl. In this case, the module consists of six ring buffers, each with four headers. Each ring buffer modulates the playback rate similar to the chord buffer to different notes, in this case to five different octaves (one octave is doubled). Each buffer is read by four

evenly spaced headers. In addition, parameters such as Density, Master Playback Rate, Lag, Pitchdrift and the Intervals can be modulated.

Spectral Delay is a feedback delay that splits the sound into nine bands. Each band is delayed randomly, depending on the amplitude of the incoming signal. In a second stage, the delayed bands are split again and either frequency shifted or pitch shifted by even numbers. All parameters including frequency range, shift, randomization threshold, and first and second delay phases are modulatable.

HFO is an amplitude modulation of the incoming signal by frequencies ranging from 0.01 to 44100 (sample rate). It crushes the sound and adds texture.

All effects, including multichannel processing, are randomly distributed at each end of the module in the panorama. The piece is dynamically adaptable for N-speakers multi-channel setups. So far, it has been performed in stereo and 8-channel stage setups. In addition, many parameters are modulated simultaneously by a single knob on the MIDI controller. The modulation weight of each parameter is also randomized. This technique is inspired by Prof. Dr. Alberto De Campo and is called INFLUX.

The piece divides into three sections and forms a cyclical movement. The beginning is a single note that is transformed by the *Chord Buffer* into a cycle of three maj7 chords. This is followed by an atonal layer of *Shepard Buffer* and *Cybernetic Feedback*, which introduces the second section. The third and last section returns to the original harmony. This time, however, the original chords are reversed and layered through the *Ocotpus*. Finally, the harmony and rhythm return to their initial state.

Overall, the piece is an experimental approach to the idea of transmutation using analog material and high technology, exploring intuitive practice in algorithmic environments.

Documentation https://vimeo.com/912967760

Mouja

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Mouja is a performance combining real-time Neural Audio Synthesis (NAS) with Thales and Stacco, two novel musical interfaces providing a fun and poetic way of navigating the latent space in NAS models through their entangled magnetic fields. In this performance, I explore the tendency of AI, emerging in my practice as well as in other artists' work, to bring forth eerie and uncanny semantics. This spectral trait may be traced back to Derrida's notion of hauntology and, after him, to the methods of the sonic hauntology movement. In *Mouja*, Thales and Stacco become a magnetic Ouija board, surprising the observer with their unpredictable magnetic interactions as the performer summons the dataset's sonic remnants from the multidimensional foldings of the latent space.

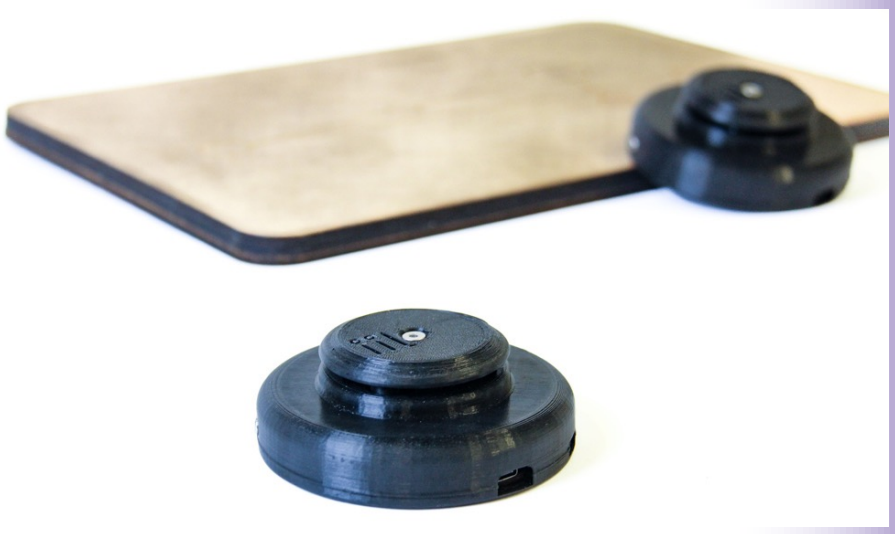
Keywords AI, Neural Audio Synthesis, Stacco, Thales, Hauntology, Hautography.
DOI 10.34626/2024_xcoax_040

Description

Neural Audio Synthesis (NAS) is a new synthesis method based on machine learning, in which the algorithm learns through a training process to represent and reconfigure corpora of raw sounds. The performer interacts with a NAS model through style transfer techniques from acoustic primes, or by manipulating a compressed representation of the dataset, usually referred to as "latent space." In this performance, I explore this second methodology with RAVE (Caillon 2021), an autoencoder architecture for real-time NAS that I control with Thales and Stacco, two musical instruments I designed for this purpose. Thales (Figure 1) is a

composed instrument presented at NIME 2023, and 3rd prize winner at the 2024 Guthman Competition, Georgia Tech University. It is based on two controllers that interact with each other, or with any other magnetic field or ferromagnetic object, through permanent magnets of opposing polarities (Privato et al. 2023a).

Fig. 1. Thales.



When the performer attempts to join them, the controllers repel each other allowing to play with the tangible manifestation of their opposing magnetic fields in a way that reminds the interaction with an invisible bouncing ball or a loose drum skin. Each controller contains a riser, held in position by the player's palm. When an opposing magnetic field is encountered, the riser activates and pushes on the performer's hand providing tactile feedback as well as the possibility of precisely controlling selected parameters by modulating the pressure. Thanks to the controllers' ability to entangle with any ferromagnetic material, it is possible to design tailored magnetic scores (Privato et al. 2023b) by embedding magnets with different sizes and polarities in the performative space or inside two or tri-dimensional boards.

Stacco (Figure 2) is a musical instrument I designed with Giacomo Lepri, aimed at the intuitive navigation of NAS models' latent space, and based on a reconfiguration of Thales' design concepts. It attracts magnetic spheres and ferromagnetic objects to a magnetic oval board, affording a fine and detailed control of selected parameters as well as the open-ended, playful exploration of the model. Alternatively, it is possible to interact with Stacco by using Thales' controllers, or by wearing a set of magnetic rings whose opposing polarity provides haptic feedback when approached to the instrument. Under the hood, Stacco features four three-axis magnetometers combined with as many magnetic attractors, controlling eight latent dimensions and informing the performer's gestures through its magnetic fields. The composer can work with Stacco through the method of *embodied sketching*, the practice of embedding the score on the instrument itself to reconstruct or suggest the performative gestures (Privato et al. 2024). Such scores consist of cardboard oval cuts placed on the instrument's top (Figure 3): since all interactions are mediated by magnetic fields, the spheres do not need to

touch the board to control the sound and multiple notational layers can be overlapped in between the spheres and the instrument.

Fig. 2. Stacco.

Mouja (Figure 4) is a performance summoning the spectral disjunctures and sonic remnants that have emerged in my practice in designing, performing and composing with NAS interfaces. With Mouja I reflect on Derrida's notion of hauntology, a framework investigating the limits of the metaphysics of presence by displacing the focus on ontological liminalities (Derrida 1993). In music, this concept is central to Mark Fisher's formalisation of sonic hauntology as an artistic movement in which musicians produced hauntological disjunctures through the deliberate exposure of the medium and the overlapping of temporally distant sonic signifiers (Fisher 2013). Derrida's notion of hauntology is also foundational to the framework I am developing to investigate the technical, social and cultural phenomenology of AI, and that I describe as *AI Hauntography*. [1]

In line with this, in this performance I investigate and magnify the eeriness of the model and its hauntological potential in several ways. Indeed, Thales interacts with a magnetic score consisting of a series of magnets hidden under an engraved board, whose engraving features an ancient Icelandic spell that people used to place under their pillow to favour sleep; Stacco is also played by combining magnetic spheres in the guise of a pendulum oscillating in response to the forces of the instruments' attractors, then displacing them on the instrument's board based on an embodied sketch developed using the techniques of spirit photography, where multiple overexposed pictures are overlapped into a single image. As the performance unfolds, different NAS models are overlapped and cross-faded, in the guise of the processes of sonic hauntology, throughout three different sonic scenes. The models have been trained at the Intelligent Instruments Lab (Iceland)[2], and they use open-source data and/or data whose use has been consented to by the authors. These include choir, organs, water, voices and magnets' sounds.[3]

A first version of Mouja has been presented at TEI 2024 (Privato 2024). The performance I propose here maintains the models but features the aforementioned method of embodied sketching with overlapping transparent scores. Also, in this version of the performance I explore for the first time the use of magnetic rings besides the spheres.

1. This framework is thoroughly described in a paper submission parallel to this performance proposal.

2. www.iil.is

3. https://huggingface.co/Intelligent-Instruments-Lab/rave-models

These novelties aim to further increase the uncanniness and eeriness that the performance conveys, to magnify its hauntological traits and expose through this process the sonic remnants that constitute the model.

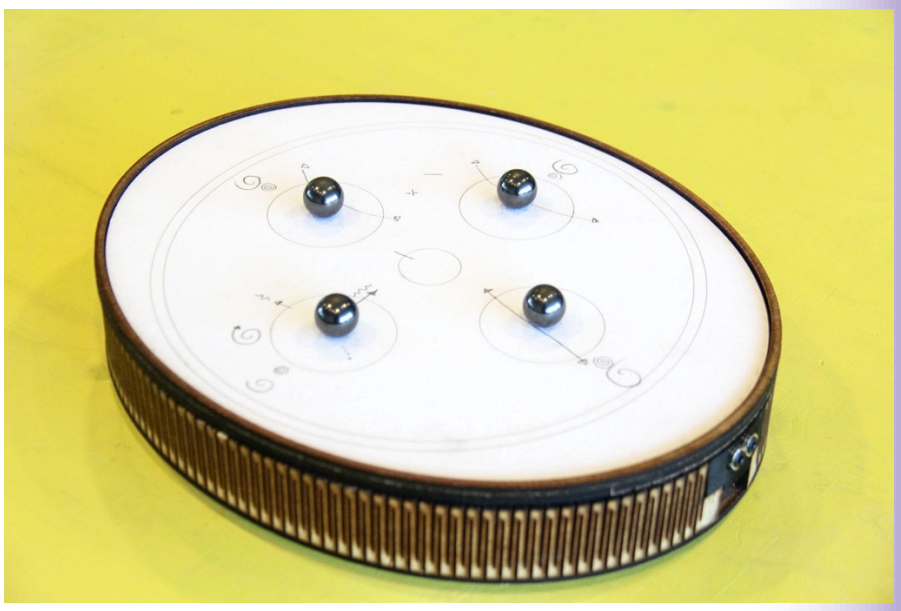


Fig. 3. Ebodied Sketch using Stacco.

Fig. 4. *Mouja* (2).

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Suspended in Gabba: Musical Improvisation for Embodied Human-Machine Learning

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Suspended in Gabba is a musical improvisation for embodied human-machine learning. This involves a methodology that is myriad and maximal in its relationship to sound synthesis and music production. That is to say that it is ambivalent about particular or specific synthesis techniques, dominant lineages of electronic music, or purist ways of working. Instead, this research project conveys an approach to sound synthesis, digital sound manipulation, and music production as a way of knowing. Many types of synthesis are messily accumulated into the performance system alongside elements such as machine listening, machine learning, sampling, live re-sampling, analysis and resynthesis, and other approaches to the creation and transformation of digital sound. Drawing on enactive-ecological, and embodied approaches to live electronic musical performance, it is the very non-linear complexity of being a living, encultured human navigating the world, encountering materials, and embodying processes that informs this way of engaging with sound.

Keywords Embodied Music Cognition, Enactive-ecological Approaches, Live Electronic Musical Improvisation, Machine-listening, Machine-learning.
DOI 10.34626/2024_xcoax_039

Description

Suspended in Gabba is a musical improvisation for embodied human-machine learning. This involves a methodology that is myriad and maximal in its relationship to sound synthesis and music production that has evolved over the last seventeen years. That is to say that it is ambivalent about particular or specific synthesis techniques, dominant line-

ages of electronic music, or purist ways of working with digital sound. Instead, this research project conveys an approach to sound synthesis, digital sound manipulation, and music production as a way of knowing. It does not discriminate on the techniques that are used. Many types of synthesis from frequency modulation (FM), amplitude modulation (AM), subtractive synthesis, pulsar synthesis, and micro-sonic techniques are messily accumulated into the performance system alongside elements such as machine listening, machine learning, sampling, live re-sampling, analysis and resynthesis, and other approaches to the creation and transformation of digital sound. Yet this work follows philosopher and cognitive scientist Hanne De Jaegher in her resistance to privileging what I will sum up in brief as the 'computational' language that is often used within cognitive science research; she asserts that "our most sophisticated knowing is full of uncertainty, inconsistencies, ambiguity, contradictions" (De Jaegher 2021, 848). Informed by enactive-ecological (Rietveld, Denys & van Westen 2018), and embodied approaches to cognition, it is the very non-linear complexity of being a living, enculturated human navigating the world, encountering materials, and embodying processes that informs this way of engaging with sound and performing live electronic music (see Hayes 2019).

Since 2007, I have developed bespoke software and hardware in order to create musical performance systems. My typical hybrid analogue/digital performance system includes laptop, custom software written in the graphical creative coding language Max, controllers, voice processors, drum machines, analogue synths, which all mutually affect each other by way of the ecological software design and machine listening techniques (see Hayes 2022). This creative practice is deeply informed by the theories of embodied music cognition, specifically the enactive-ecological approach (Hayes & Loaiza 2022). In this, the affordances of my system are not cerebrally mapped out, but are explored–and music is produced–via the dynamic, playful, and ongoing navigation between myself and the system. Musicologist Jacob Hart has provided an in-depth technical analysis of a recent iteration of my performance system, yet astutely notes that: "it is a complicated web of interconnecting parts, a sonorous body that will produce sound without her intervention; small changes in her gestures are amplified through a chain of connections of agency into sonorous results that can be unpredictable. This is something that she actively looks to create. When looking at the complicated state of the Max patch, we can conceivably extend this idea to the code itself: an impenetrable object, full of agency, which the musicker must resist and fight to find a place in" (Hart 2021, 213-4).

Fig. 1. Embodied hybrid analogue/ digital performance system in 2020. Image credit: Tobias Feltus.

The design of the enactive-ecological performance system (see Figure 1) is informed by early models from cybernetics and artificial life and has explored notions of feedback, unpredictability, autopoiesis, and dynamic systems. As musician and scholar Tara Rodgers has noted, "To take seriously [an] analogy between sounds and forms of life-as fleeting, overlapping, and ever in transformation-requires that we dismantle the subject position of detached and knowing observer that persists in audio-technical discourse, and recognize ourselves amid the currents, always provisionally defined in relation to other humans, species, things and environments" (Rodgers 2016, 209). In the case of the human, the design has been shaped by the many communities of practice that I have participated in over these years, by way of friends, mentors, educators, students, collaborators, workshop leaders, workshop participants, community groups, ensembles, research groups, and so on.

More recently, this performance system has incorporated machine learning and complex sound decomposition techniques as part of my participation in the Fluid Corpus Manipulation (FluCoMa) research project, University of Huddersfield (Tremblay, Green & Roma 2019). Within this community of practice, I was commissioned as one of eight international artists to create a new work using the creative coding toolkit. The project studied how creative coders and technologists work with and incorporate new digital tools for deconstructing audio in novel ways. This project allowed me to explore if and how machine learning could be used to augment my already mature improvisational system in Max, and how this could be embodied through performance practice. In *Suspended in Gabba*, I implement and perform a technique that I describe as 'third-order improvisation'. Firstly, I perform and record an improvisation; then, I segment the recording, order the segments according to a variety of descriptors, and then re-improvise with this ordered material using k-nearest neighbour (KNN) algorithms within FluCoMa to create punchy percussive and rhythmic patterns that I can move away from gradually–or rapidly–into new sonic territory. This second pass is also recorded. Finally, this material is then re-improvised live via another

KNN-based approach that is tailored towards real-time performance and omits various computationally intensive analysis elements.

Suspended in Gabba seeks to question, challenge, and reshape the established protocols of sound synthesis and electronic music performance by drawing inspiration from the enactive-ecological framework, incorporating the historic, emergent, and structurally-coupled relationships between musical agents, materials, and sounds. In her work on digital musical instrument design and "embodied autoethnography" (Mainsbridge 2022), musician and scholar Mary Mainsbridge exemplifies this process, stating: "I refine the instrumental and expressive capacity of my body as it develops through varied activities and phases" (Mainsbridge 2022, 5). The title of the project alludes to one of many such 'activities and phases' of music as I it experienced viscerally–as loud and fast beats, distorted bass and kick drum in rooms full of moving bodies–in the late 90s. Yet, earlier still, it was the physicality of learning to play and create music on acoustic piano that I struggled with and embodied as a young child. This project explores live electronic musical performance and sonic art through this historic, encultured, and very much embodied lens. It is not the technological developments that are necessarily of importance within this practice: it is the socio-musical configurations that are reified within the embodied performance of such techniques that hold the most potential for creating new (musical) worlds.

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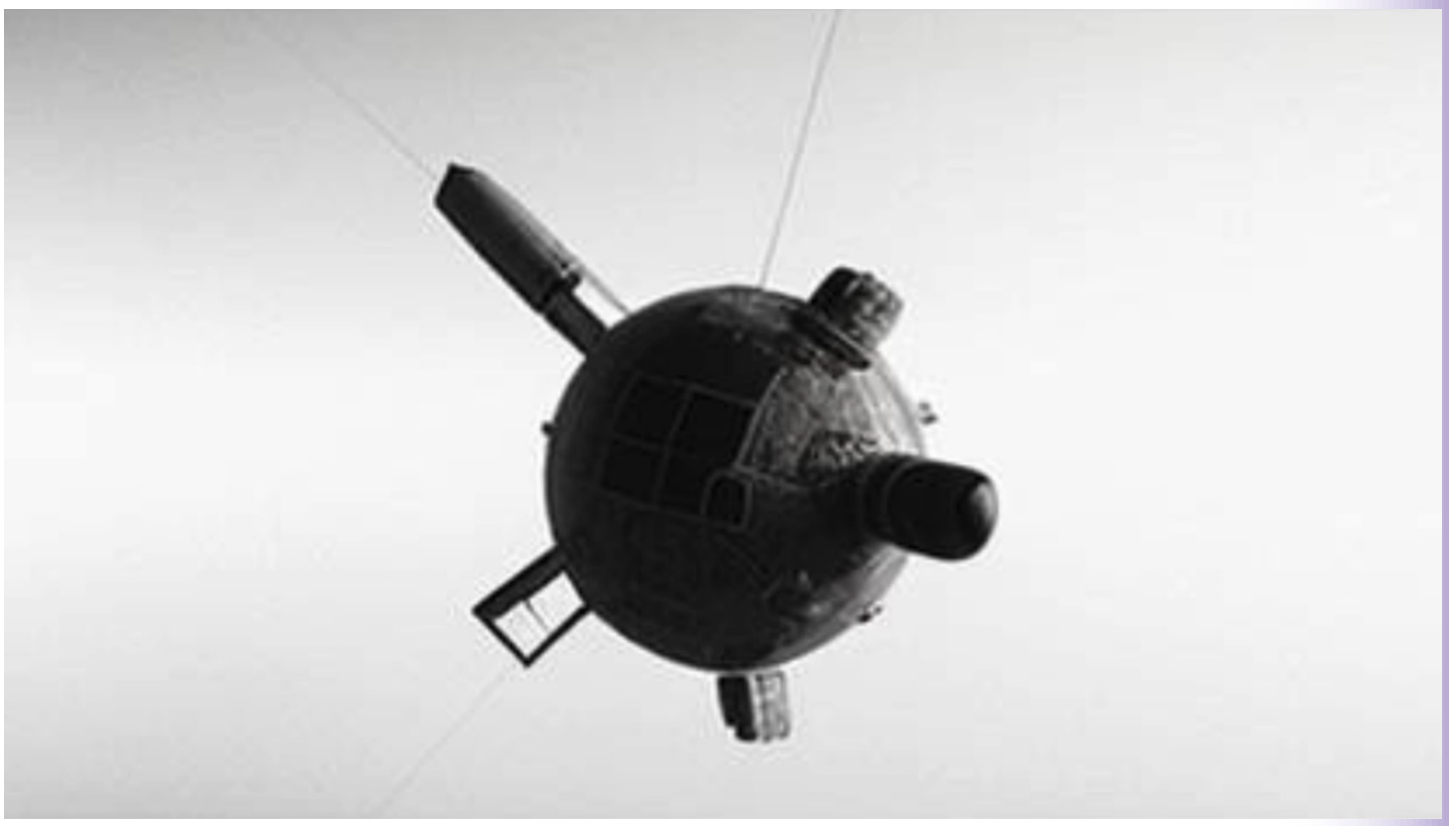
Evolution of nSpace (2004–2024)



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The Evolution of nSpace is an experiment in 'pataphysical filmmaking. The film is generated in real-time through custom-made optical/sound apparatus (see Fig. 1) calibrated to the music of the Opalio brothers, and with the participation of the audience. The format, style, and process draws on 'film d'art' or Art Cinema motifs and practice. Until the moment it is observed by the musicians and other participants during the performance, the film exists only in a 'quantum cloud.' [1] At run-time, the film's superposed elements are procedurally edited and sequenced; collapsing the quantum cloud of the film into the resulting (observed) timeline. In the 'pataphysical tradition, the film is presented as a factual embodiment of inventions which presently, from the perspective of generalised science, remain impossible. The film/performance becomes contemporaneously evidence and artifice, *both* science and fiction. Will the growing use of (super) intelligent systems lead to an understanding of the universe as infinitely *knowable*? If any question can be computationally resolved through the statistical inference of probabilistic models based on the constant and indiscriminate accumulation and control of data, what, if anything, remains unknowable?

Keywords Pataphysics, Speculative Design, Science Fiction, Cybernetics, Quantum Theory.
DOI 10.34626/2024_xcoax_045

Project, process and operation

> *'Pataphysics will be, above all, the science of the particular, despite the common opinion that the only science is that of the general. 'Pataphysics will examine the laws governing exceptions, and will explain the universe supplementary to this one.*[2] *—Alfred Jarry*

At the heart of the project, *The Evolution of nSpace*, is an automated-art-system consisting of custom-made equipment (see Fig. 1) which uses computer vision and sound analysis to generate images which are computationally arranged into film sequences in real-time. This apparatus and its custom-coded software, is calibrated to be used with either an amplified phonograph record, or the live performance, of sound-art by Maurizio and Roberto Opalio (aka My Cat Is An Alien) in order to generate a parallel live-video feed of a unique science-fiction film.

The film, although completely generated frame-by-frame in real-time, is designed to proceed through three distinct parts or acts. Each act is narrated through subtitles generated with custom-coded scripts for synthetic language which stems from, and contributes to, the ongoing creation of the film.

Fig. 1. Custom-made apparatus, vinyl phonograph disc and player for calculating Tonalytic Trajectories for the *Evolution of nSpace*, Donnachie & Simionato, with Maurizio and Roberto Opalio, 2024

ACT I: Phonon Conversion

The first act introduces the 'pataphysical invention of 'phonon conversion,' the principle underpinning the generation of 'Tonalytic Trajectories', converts phonons (quantum units of sound) into photons (quantum units of light).[3]

The synthetically generated narrative describes how, before the invention of the Phonon Converter, there was no known way to directly convert phonons, or the lattice vibrations in solids into photons. Additionally, the synthetic narrator describes how computational sound

1. The automated-art-system which generates the film, here envisioned through the metaphor of a 'quantum cloud' references the principles of superposition of quantum mechanics, where a particle doesn't have a definite position until it's measured; Superposition in quantum mechanics refers to the ability of a quantum system to exist in multiple states at once. The principle of superposition, as described by Paul Dirac, suggests that a quantum system can be in a combination of states, each with its own probability. This means that a quantum system can be considered as being partially in several states at once, without these states interfering with each other; "The intermediate character of the state formed by superposition thus expresses itself through the probability of a particular result for an observation being intermediate between the corresponding probabilities for the original states, not through the result itself being intermediate between the corresponding results for the original states" P.A.M. Dirac. 1947. *The Principles of Quantum Mechanics* (2nd ed.). Clarendon Press, 12.

2. 'Pataphysics, as established by Alfred Jarry, is an artistic practice that challenges the determinism of classical Newtonian physics.; Alfred Jarry, 1996. Exploits & Opinions of Doctor Faustroll, Pataphysician: A Neo-scientific Novel. Boston: Exact Change, 21; Christian Bök explains Jarry's 'pataphysics prefers to

analysis and Cross-Modal Encoding, permits a quantum superposition that allows data (generated as sound) to be transmitted via photonic spectra. In other words, with phonon conversion, lattice vibrations in solids can now be harnessed to produce a photon beam capable of propelling and steering a spacecraft, by converting sound to photon-encoded data suitable for transmission via a synchronised audio-to-optical interface.[4]

ACT II: Tonalytic Trajectories

In the second act of the film a Tonalytic Trajectory system which controls the movement of spacecraft based on photon beams produced by focused tones or music, is described. Intentional music compositions are crafted, or, in the case of skilled musicians improvised, to direct a spacecraft along desired orbital paths. Different tones, rhythms, and chords produce different wave shapes, to sculpt the trajectory.[5] For example, music produced in a major key can send the spacecraft outward on escape trajectories; dramatic diminuendos may be used to slowly spiral inward; and complex polyrhythms used to enable intricate course adjustments.

ACT III: Experiencing nSpace

In the final act, the viewer is invited to directly experience travelling through nSpace through these new inventions under the "controlled conditions designed for safety and comfort". As the viewer begins to move through various iterations of nSpace they may experience feelings of disorientation and other somatic sensations. These are expected.

You are now entering nSpace. Welcome.

Notes

The title of this project is taken from a series of photographs and related works Donnachie and Simionato began making and publishing in the early 2000s. For these projects, small objects (representing platonic shapes such as cubes, cones and spheres) were photographed on existing printed publications in ways intended to problematise the viewer's perspective, either collapsing the illusion of depth, or otherwise disrupting our perceptual resolution, of the original, underlying image. We even created a series of anaglyph images of these same objects for a small exhibition in Paris, inviting the viewer to see the (2-dimensional) images of the (3-dimensional) objects through red/blue glasses.[6]

explore the "surrational potentials of such physics… what is random and absurd"; "'Pataphysics is speculative, waiting for its chance to happen, as if by accident, in a theme park of scientific conception."; Bök reminds us that "Science suggests that what is probable coincides with what is most provable[…] not because they can be proven but because they can be probed. There are "probeable" systems."; Christian Bök, 2002. 'Pataphysics: The Poetics of an Imaginary Science Northwestern University Press, 29; Andrew Hugill and James Hendler in "'Pataphysics and Computing" also trace an entanglement between artistic research and quantum computing through the lens of 'pataphysics.

3. Phonons represent the quantum basis of acoustic propagation through solids. On a quantum level, the vibrational motions caused by the music involve discrete quantized excitations of the vibrational states of the crystal lattice— and these quantum mechanical vibrational quanta are called phonons. Through careful tuning of the system (in a probabilistic combination of spatially separated vibration states), applying a phonon at a certain frequency stimulates the emission of a photon in a predictable way while preserving the superposition. Detecting the output photon 'collapses' the superposition (into either one vibrational state or the other). In the interim, there is a direct linkage between the phonon input and photon output at a quantum correlational level through the shared phononic superposition. In other words, phonon conversion effectively translates between macro-scale sound wave vibrations and light emission events tied to underlying molecular phonon and photon dynamics.

Fig. 2&3. Early photographic studies of the *Evolution of nSpace* published in *This is a magazine*, 2009.

4. "Photonics Reshapes the Future of Computing" in Photonics Spectra Feb 2024. https://www.photonicsspectra-digital.com/photonicsspectra/february_2024?folio=36; See also Programmable photonic integrated circuits (PPICs) which process light waves for computation, sensing, and signaling, in https://phys.org/news/2024-02-key-photonic-components-supercomputing-technology.html.

5. Similar to the subjective experience of superposed acoustic phenomena such as Shepard's tone, superposed light waves may conjure unique visions in viewers. These waves may be perceived by the audience as images, although studies in Quantum dream state visualisation reveal that due to the subjective influence photon wavefunctions have on human consciousness, each participant may experience unique perceptions of images and environments (in other words, results may vary); Traditional visualisation shows photon waves move linear forward, while they wobble and pulse in planes perpendicular to their direction of motion. Visually the wave shape oscillates up and down sinusoidally and cycles in intensity over space and time.

6. "Evolution of nSpace." in *Archistorm*, Paris, France, 2010, curated by Catherine Geel; in *Activities in Space and Time*, Warm Grey Gallery, Paris, 2010; in "Pink Laser Beam," *This is a Magazine*: Compendium #6, 2009.

After twenty years, these same small objects have found their way into a new iteration of the project. They represent an evolving system for articulating, understanding, and moving in, through and beyond generalised space with the help of computational systems. They offer opportunities to explore the science of the exceptional.

Acknowledgments: This artwork uses a number of open-source libraries, software and tools— Quantum Fourier Transform and Fourier Transform tools for acoustic analysis and conversion; NASA's open-source GMAT system for space trajectory optimisation, navigation, and flight analysis (see https://gmatcentral.org); Arduino and Adafruit libraries to drive the kinetic Phonon Converter; and Python, OpenCV, Blender, WebGL, Javascript (p5.org, threejs.org), with Stable Diffusion (Stability.ai), for the procedurally generated film.

Evolution of nSpace Video presentation https://vimeo.com/912892331

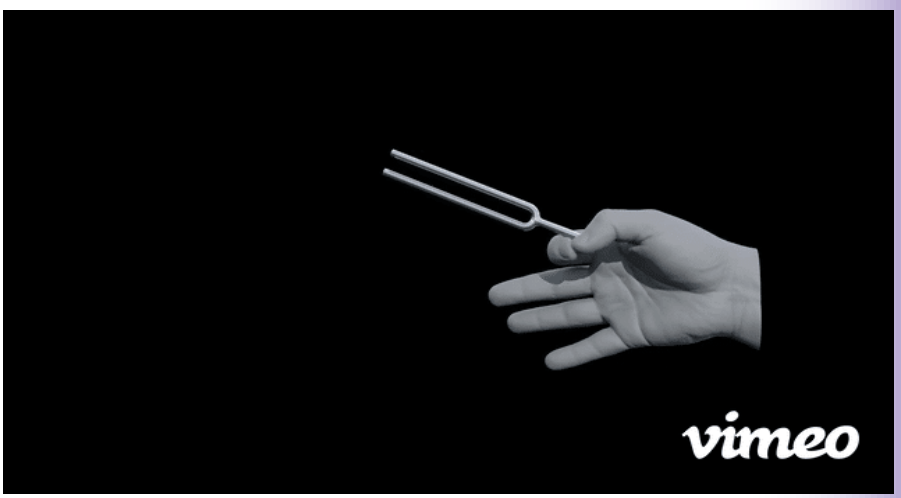

Fig. 4. *Evolution of nSpace*, [presentation video] 2024 (https://vimeo.com/912892331)

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Sunspeak: A Networked Solarpunk Performance

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Sunspeak is the outcome of an experimental research project conducted using discarded electronics, embedded microprocessors and photovoltaic (PV) cells to charge salvaged power cells. The components are retrofitted into a set of portable telecommunication handsets with additional inputs which send data via the OSC protocol over a local network to control granular synthesis and audio processing within software powered by Max/MSP. Each handset is powered by a re-chargeable battery cell taken from a discarded disposable vaporiser, running custom software on a Raspberry Pi Pico W written in C. The devices each display a unique text-based onboarding gameplay and graphical representation of user input, whilst transmitting OSC data via UDP using the boards integrated networking capabilities. The system is designed as a networked instrument to facilitate a collaborative improvised performance, that can be situated as a standalone performance or within a thematic solarpunk world building experience.

Keywords Solarpunk, Participatory Performance, Computing-within-limits, Improvisation, Embedded Systems.
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Description

Introduction

Configured as a solarpunk world building experience, *Sunspeak* invites five players to participate in an improvised collaborative performance. It uses networked portable wireless controllers that shape an immersive audio-visual performance. Exploring the nature of distributed and

consensus decision making, the piece requires collaboration between participants to guide the experience, with moments of discord and harmony emerging based on the agency of each player.

This work is inspired by and draws from the solarpunk genre as a space for eco-futurist fabulation and an approach to design. At a material level solarpunk focuses on critical engagement with technology, resource management, and collaborative work, rejecting the extractive conditions that 'technological solutionism' (Morozov 2012) has perpetuated under capitalism. Solarpunk looks to communal and collaborative infrastructure, envisioning techno-futures and knitting social alternatives that counter planetary scale computation with optimistic, local and often simpler, lower-tech solutions.

> *In a time where computing epitomizes industrial waste, permacomputing encourages the maximizing of hardware lifespans, minimizing energy use and focussing on the use of already available computational resources. (Viznut 2022)*

From a literary perspective the genre loosely defined as solarpunk has its roots nestled in the eco-feminist writings of Ursula K. Le Guin and Donna Haraway. These texts underpin a field of research collectively referred to as 'permacomputing', which brings together speculative-fiction with the critical theories of eco-futurism to form a critique of computational maximalism. It is within this context that the following work is situated.

In Sunspeak I attempt to bridge material considerations and speculative fiction approaches, entwining design methodologies with storytelling. The physical origins of the project respond to the repurposing of discarded single use and obsolete technologies to experiment with social infrastructure that encourages collaborative performance and storytelling through a low-power, solar-powered participatory communication network.

Telecommunication Handsets

The work is facilitated using a set of five handset controllers which are made up of retrofitted portable handheld televisions. I have stripped the original circuit boards and designed new internal electronics, which are networked with a Raspberry Pi Pico W microprocessor as the brain. Given that terrestrial broadcast signals have been gradually switched off internationally over recent years, these devices serve merely as relics of an analogue communication past; technological detritus that is widely available second-hand for little – if any – cost, otherwise fated to landfill.

I have made use of the exterior buttons originally used for tuning the device, but have rerouted them in the new circuit design and allocated new functions to them. They are now used to progress between pages on screen within the new software installed on the microprocessors. Additional user input is provided in the form of a potentiometer mounted through the original socket for an external antenna. The analogue potentiometer input is smoothed, mapped and sent wirelessly via the OSC protocol to a granular synthesiser programmed in gen~

within Max/MSP. Input data from each device is received and parsed in a max patch, and then routed to the main audio processing patch where it is mapped to a specific parameter, manipulating field recordings, some of which are made with a simple solar powered amplitude-modulation synthesiser.

Fig. 1. Two handsets refitted with Raspberry Pi Pico W and bespoke circuitry.

Fig. 2. Handset in use during performance.

In place of the original display, I have installed and mounted a 1.3” OLED screen which displays preliminary onboarding text and graphics to represent the input data from the potentiometer. The displays are mounted with a custom fabricated part that I designed and 3D printed with recycled PLA.

Sweet, sweet (smelling) batteries

Noticing the vast number of discarded disposable flavoured vaporisers littering the streets, my investigations led me to dismantling the devices and testing the internal electronics. As it happens, the lithium-ion batteries installed to power the devices had the ability to be recharged safely countless times, with no loss of specified capacity after recharging at an optimal charge voltage. The vaporisers simply had no means of recharging the batteries, as the primary economic motives of the production of the devices was to sell as many disposable units as possible. The batteries I salvaged varied in capacity between the vapes that I pulled apart, but all had an operating voltage of 3.3 volts, which happens to sit within an appropriate voltage range to safely power a range of microprocessor boards.

I desoldered the cells, taking care not to short them, and re-soldered to modular JST connectors, which I then recharged with a 6 Watt photo-voltaic solar panel, using a voltage control TP4056 chip to regulate the incoming voltage from the solar panel and the outgoing charge to the battery. The energy stored by the battery is then used to power the networked handsets, which could last for several hours on a single charge. According to Alex Nathanson's top level descriptors of the three common designs of solar powered circuits, this approach could be classified as "long-term energy storage with batteries" (Nathanson 2021, 31) as it uses and stores PV energy for short term use. [1]

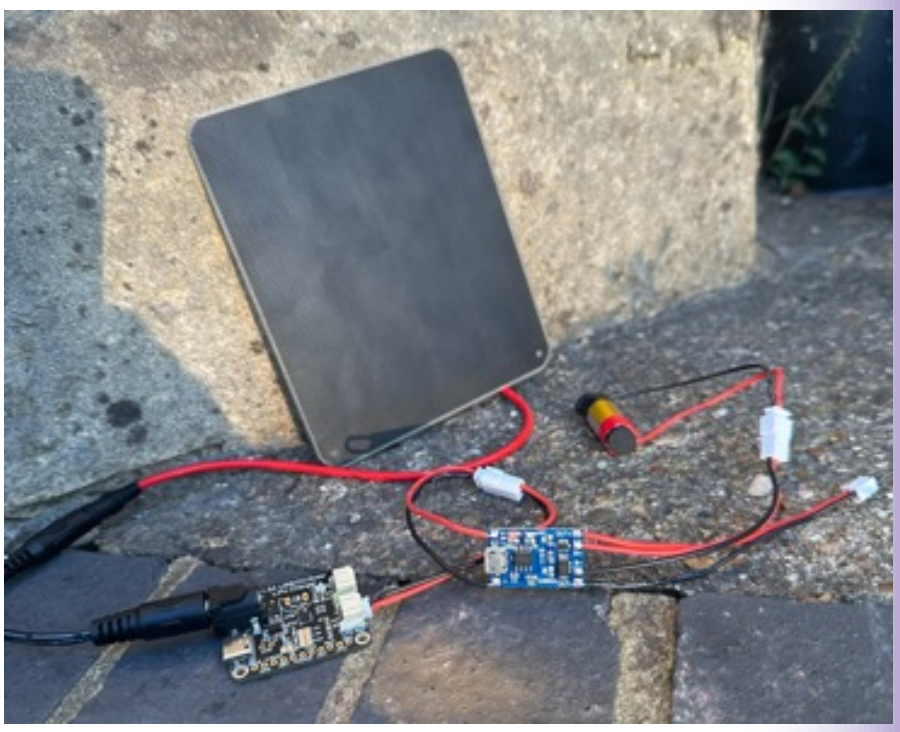

Fig. 3. 10V, 6W PV solar panel connected to TP4056 charge control chip, charging salvaged 500mAh cell.

Due to the nature of the original use, once I had extracted the battery cells from the vaporisers, they had a lingering smell of the fluid flavour from the device that they had ben pulled from. My workstation gave off the sweet scent of grape, mango, and cola. Interestingly, as I dismantled devices from each of the most well known competitive vape brands, I noticed that the battery cells used were wide ranging in manu-

1. Nathanson's other top-level descriptors are direct-drive design, which uses solar energy directly with no storage or power conditioning capabilities, and short-term energy storage that may or may not include power conditioning. An example of this would be a classic scientific calculator which is powered by a small PV cell and has very short term power conditioning.

facturer and capacity, even when from the same product line. Usually, these types of individual cells would be assembled together in series to form larger capacity 'batteries' for a wide range of consumer products. It was peculiar to find the individual cells fitted with such haphazard wiring as demonstrated in the devices I took apart. I can only assume that the li-ion cells used in the vaping devices were actually 'b-grade' cells that were rejected from the production lines of composite battery units. This suggests that the cheaply made vaporiser devices were themselves the bi-products of mass production manufacturing, in a way providing a first stage repurposing of materials.

Building a solar recharge station for these disposed cells is the most explicit result of my research into the solarpunk genre as an approach to design and infrastructure, by providing a means to explore the options for recycling and reusing discarded electronic materials within new design frameworks. Envisioning a more sustainable world that aims to reduce the discarding of technology requires an approach that engages critically with the status quo of contemporary manufacturing and explores design considerations with a material focus.

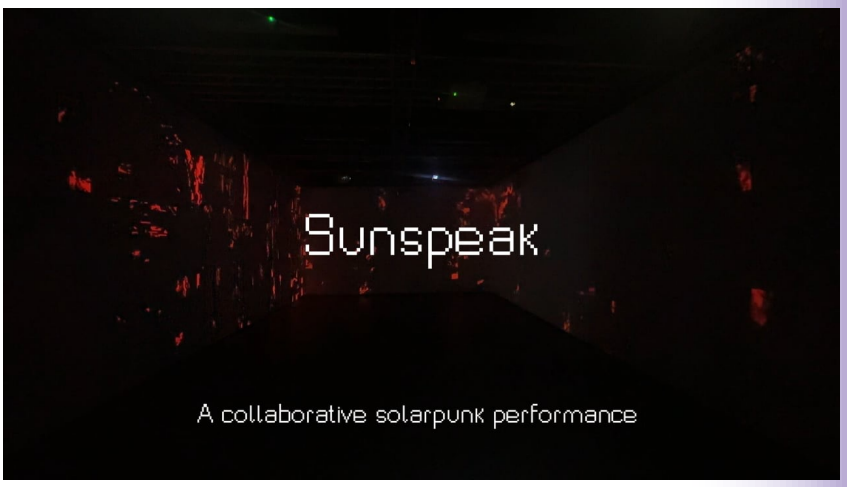

Fig. 4. Video documentation of performance (http://vimeo.com/862680790).

Emergent Performance

I devised this work as part of an MA programme in Computational Arts at Goldsmiths College, University of London, where I presented the first iteration of the piece as an improvised performance using multichannel sound and immersive visuals that were also mapped to the input of the handsets. During the course of a four day exhibition, I conducted the performance four times, each with a different set of participants who signed up on the day. I programmed each device with its own text-based narrative introduction and training game, which I used as an onboarding exercise for the participants to familiarise themselves with the devices and how they influence the networked instrument. Each performance began with a group read-through of the text, situated as a communication exercise in a sci-fi LARP (live-action-role-playing) experience. I took on the role of the dungeon-master to assist with the onboarding of performers, before taking a retreated position at the mixing desk to keep an eye on audio levels in the space.

As the performers took agency over the controls of the networked instrument, the performance unfolded as a unique improvised soundscape, with four completely different works emerging over the weekend. As an experimental participatory performance, I was interested in the dynamics that underpinned the collaborative workings of the performance. Much like traditional musical performance, the piece required each performer to listen closely and observe the unfolding work, and work with each other to shape the audio-visual journey.

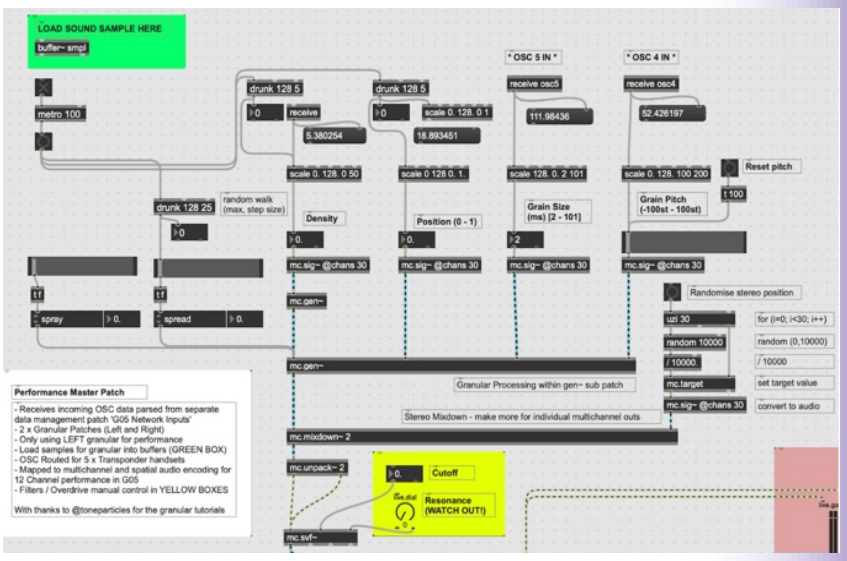

Fig. 5. Granular synthesis patch in MaxMSP, a section of a larger patch in which all audio processing for the project takes place. OSC control is mapped to two parameters of the unit; 'Grain Size' and 'Grain Pitch'.

Technical Details

The initial run of performances made use of open source ambisonic external devices from ICST to control some simple spatialisation within the main max patch, with surround panning controlled by one of the handsets introducing a distinct spatial element to the work to increase the level of immersion during the performances.

The first iteration of the work was presented in a specialist room with almost fully-surrounding projection screens, which was utilised for the performances, parsing handset data back out from max into a generative TouchDesigner composition. The projection spanned 9600 x 1080 pixels and was output via NDI to Resolume Arena where it was mapped for projection across the 5 channel projection array. For this setup, potentiometer data from each of the handsets was carefully mapped to a different parameters within the composition to influence the visual output in relationship to the audio output.

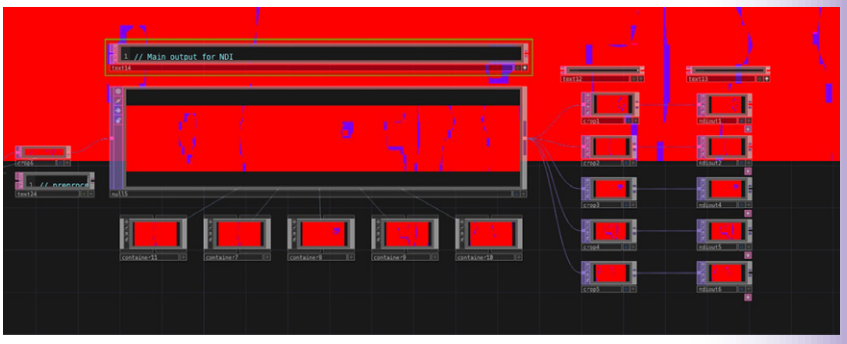

Fig. 6. Network view in TouchDesigner: breaking down a 9600 x 1080 image into 5 component images to send out via NDI outputs to be received and mapped for projection.

Whilst this approach utilised a range of computationally demanding audio-visual processing hardware and software, I opted to use them in conjunction with the repurposed handsets to demonstrate how low-power electronics can be merged within contemporary audio-visual solutions. In the time since initially presenting the piece, I have been developing a supplementary device in order for the work to be run as a standalone set of tools that do not require media servers or even a laptop to be performed, integrating the granular synthesis into an embedded device using an ElectroSmith Daisy Seed microprocessor and solar powered dub pedal to granulate and process the audio.

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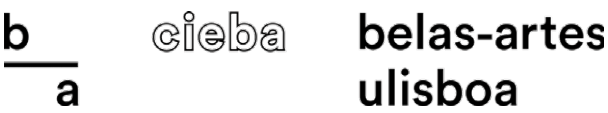
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