Ars Memoriae

The Art to Remember

Artistic reflection and documentation of artistic result submitted in partial fulfillment of the requirements for the degree of Philosophiae Doctor (PhD) in Artistic Research at the University of Bergen. Date of public defense: 18.10.2024.

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Cover image: Maarten Vanden Eynde, *The Last Human*, 2017 (Photo: Philippe De Gobert)

Contents

Introduction

In times when humanity, particularly in the Western world, seems to be preoccupied not only with dying but, more importantly, with dying out (Weisman, 2007; Zalasiewicz, 2009; Kolbert, 2014; Scranton, 2015; Zwicky & Bringhurst, 2018; Dunn, 2021; Pyne, 2022; Doeland, 2023), questions about legacy and commemoration become inescapable and irrevocable. What will humankind be remembered for? What kind of material traces will be left behind, and how will these remnants be interpreted or read in the far future, and by whom? And more philosophically, from the perspective of Biological Intelligence, as opposed to the omnipresent Artificial Intelligence, what does it even mean to be human?

Once the intracranial augmentation of memory processes by implanting wetware computer technology becomes the norm, the difference with biological humans will be too big to be able to speak of the same species anymore. This shift towards trans-humanism will be so significant and influential that it might instigate the very end of the genus *Homo sapiens sapiens* altogether. It begs not only the question of how we will be remembered as a species but also how our conventional (dare we say *old-fashioned*?) way of remembering will be remembered. How will the stories of the rise and decline of memory aids be told in the future? And will they be told by the last representatives of our species, in an act of *memento mori*, or will they be told by the new trans-human entities that might not be so interested in, obsessed with, or hallucinating about their past, the way humans are? But if they are, as a result of human source code programming, what will these new entities think (if it is still called thinking) or say (if speech is still a thing) about humanity's enduring attempts to alter their limited brain capacities by inventing external memory devices? Will they see or calculate them as necessary evolutionary steps towards Artificial Intelligence? And what will they make of the role of *Art* as a prefix and precursor in the invention of the *Art*ificial? Was art invented to help humans remember? Was it the determining driver of human intelligence?

These wide-ranging open-ended questions led to the following central research question: What role did art play within the larger history and evolution of external memory devices? Throughout my Ph.D. research project, *Ars Memoriae: The Art to Remember*, I analyzed this role in a variety of ways, ranging from making artworks, thinking and writing about making, exhibiting and curating works of art, and engaging in cross-disciplinary exchanges and shared fieldwork experiences with like-minded peers from many different fields of study. As an artist, I predominantly worked with material carriers of memory and utilized the power to communicate thoughts and emotions by skillfully manipulating matter. I interrogated contemporary materialism and material culture through the process of making art.

In general, I looked at material traces of remembering and the invention of an ever-changing body of language expressions, such as signs and symbols, to enhance the capability of storing, recalling, and communicating. I followed the externalization process of emotions, experiences, knowledge, and information, starting in the Early Stone Age, or Palaeolithic (about 3 million years ago), until, in a speculative future, it was internalized again using artificial wetware, neuro-computers, and DNA coding. Rather than analyzing specific objects, places, or periods in depth, a wide variety of interlinked events, inventions, and locales were taken into account because history is not an amalgam of independent moments and momentums; instead, it behaves as a rhizome or chain of interconnected activities that influence its course. Only by following the ripples that occur when a stone hits the water, going as

wide as possible in all directions, can my research project come full circle and lead to an understanding of evolution in deep time.

As a key methodology, I followed a holistic[1] approach and subscribed to the cross-disciplinary systems theory (Bertalnffy, 1968; Lovelock, 1979; Bateson, 1979; Capra & Luisi, 2014) to find canonical correlations and understand the evolutionary trajectory of external memory devices. I implemented a holistic methodology both in the way I looked at time, taking into account forms of evolution that took several millions of years to materialize, like human cognitive evolution or the invention of symbolic thought and expression, and in the way I looked at art, indiscriminately embracing the entire cultural history of human expression. I did not reverberate the recently introduced separating terminology related to history and *pre*history (using the presence of 'written records' as the marker between them), nor did I spend much time echoing the artificial barriers between prehistoric art, modern art, and contemporary art. Rather than isolating distinct notions of art and focusing on possible differences, I wanted to emphasize their interrelations and interdependencies, or, to speak with Canadian artist and author Natalie Loveless; I wanted to embrace their *polydisciplinamory* (Loveless, 2019). Within my artistic research, they were all part of the same umbilical cord of human culture.

This was, however, not an attempt to create a *Theory of Everything*, or TOE, a unified ultimate field theory, or coherent theoretical framework of physics that entirely explains and links together all aspects of the universe, as many of the world's most brilliant minds have tried (Newton, 1687; Einstein, 1921; Hawking, 1988; Hawking, 2003; Bryson, 2004; Weinberg, 1994; Weinberg, 2015; Spier, 2015; Carroll, 2016).

And neither was it an attempt to look at the entire evolution of life (Dawkins, 2004; Dennett, 2017; Gee, 2021) or even humankind (Diamond, 1999; Harari, 2015; Graeber & Wengrow, 2021; Pettitt, 2022). I instead focused on the evolution of one particular item, commodity, property, or technology, namely external memory devices, in a way that many researchers and others have done before me, like Gary Tomlinson for music (Tomilson, 2015), Jay Griffiths for time (Griffiths, 1999); Morten H. Christiansen & Nick Chater for language (Christiansen & Chater, 2022), Karenleigh A. Overmann for numbers (Overmann, 2023), Matthew Cobb for the brain (Cobb, 2020), Sven Beckert for cotton (Beckert, 2014), or Tim Ingold for lines (Ingold, 2007). This methodology of cross-disciplinary research into the influence of one specific thing on the evolution of humankind was a way to delimit the overall scope without losing the macro *longue durée* perspective.

Throughout the research project, writing became a memory device in itself, helping me retain references and insights and proving time and time again that memories are fleeting and constantly changing. Capturing memories of experiences through writing (and making artworks) brought new knowledge (and memories), reinforcing or contradicting the initial experiences. Simultaneously, this remembering process was a way of imagining what happened and, as a result, led as much to the forgetting of the initial experiences (which is put forward as a biological inevitability in the second chapter) as it does remembering them.

Next to an overview of all the activities that happened during my research period, including artworks that were produced and exhibitions that were created, this publication contains written reflections related to the documentation

[1] Holism is not understood here as a biological cause of evolution or a way to explain the ordering and regulative properties of the universe in general, as the South African Field Marshal Jan Smuts proposed when he coined the term in 1926 in his book *Holism and Evolution*. It is used from a more contemporary and physics-oriented perspective, incorporating the non-separability of physical systems from their parts to look at history at large as a non-separable chain of events.

and translation of the content, the process, and the evolution of my journey. Because of the eclectic nature of personal memory (my own) and species-specific memory (the human mind and humanities' mind), I wrote four separate chapters that each touch upon externalizing memory through art differently, emphasizing the intrinsic and interconnected properties of the subject matter. They each have a different and distinct perspective, a changing timeframe and tense, and graphic design.

The first chapter, *The Road Ahead*, is written in the present tense, from the first person perspective, talking about what I see, experience, and think within one specific day during a research trip in South Africa. In a road trip style and a personal diary design, I describe what happens, with whom I'm traveling, and what we are doing there. At the same time, I draw philosophical and speculative analogies between the making of an adventurous research trip, full of uncertainty and challenges along the way, and the process of doing a Ph.D. It is a snapshot memory of one specific day, February 27th, 2023, which I will remember for a long time because of the physical and emotional density and intensity, but ironically also because of the repetitive exercise to remember while writing about it afterwards. I chose this day because it gives more insight into my particular process of doing artistic research, which almost always involves fieldwork (physically being *in situ* in a place of interest), cross-disciplinary collaborations (walking and talking with a variety of people), and contemplating on a meta-level about the new experiences. It's a form of live rendering while it unfolds, leading to reshuffling and rearranging previous experiences and understandings. This perception-based triangulation between place, people, and philosophical pondering forms the fertile foundation of my art practice.
On days like this, I am totally in my element, and the firing of neurons in my mind causes a prolonged flow state of hyperfocus, referencing Hungarian-American psychologist Mihály Csíkszentmihályi.

In this chapter, I attempt to (re)capture what happened in my mind and the rest of my body, taking you, the reader, with me on this journey. Keep in mind that my memory of the initial experience has changed multiple times due to the attempts to retrieve information related to that day, and so will yours. Never mind: forgetting and fabulating are an inevitable part of remembering. This is something that even the memory device I currently use, making written records (of that particular day), cannot remedy. It is, however, the closest I can get to a form of situated presentness, being there in the moment, taking my future self and you with me on that day. The final version of this chapter is an endlessly recycled collection of memories now *written in stone,* as it were, hopefully helping me fight the further erosion of that exceptional experience.

The second chapter, *Art as a Memory Device*, is written from a speculative *future-past* perspective, looking back at the influence of art and the invention of external memory devices on the evolution of humankind. The text is designed as a research paper and written from an outsider third person perspective, negating my presence while talking in a plural form about humanity at large and encompassing millions of years, both in the past and the future. First, I focus on the biological body and its capacity, but more importantly, its limits of remembering, illustrating the need to invent memory systems and techniques to boost information storage and retrieval functionality to facilitate communication.

Although I briefly touch upon the process of externalizing memory through intangible bodily expressions like mimicry, gesture, dance, rhythmic movement, sound, and speech, the main focus of my research project and the subsequent reflection is on tangible memory aids making use of material carriers that

function outside and beyond the human body. I look at the earliest examples of the cognitive externalization process, or *thinking at a distance*, and introduce the first examples of symbolic thinking and abstract representation stemming from neurological networks in human brains. Rather than calling them "external memory systems" or "artificial memory systems," as Italian archaeologist Francesco d'Errico proposed when introducing the concept of disembodied memory (d'Errico, 1995; d'Errico et al., 2003; Henshilwood & d'Errico, 2011), I use the term "external memory *devices,"* grounding them in material epistemology. For a similar reason, I don't use the term "external symbolic storage" as proposed by Canadian neuroanthropologist Merlin Donald in his groundbreaking book *The Origins of the Modern Human Mind* (Donald, 1991) because symbolic storage, in this case, is not necessarily confined to material carriers, even when it is external.

I introduce art and artistic gestures as the main driving force behind the evolution of external memory devices. Art is being understood here, coinciding with the earliest phase of externalizing memory, as a particular skill, a specific human gesture relating to the making of artifacts (from Latin arte "by skill," ablative of ars "art;" + factum "thing made," from facere "to make, do"). My definition of art within this artistic research project is the skillful making of artifacts and gestures (both aesthetic and functional) to externalize thoughts and emotions for the purpose of communicating them with others (and oneself) while establishing self-consciousness through prolonged perception and remembering.

In this chapter, I present examples of artworks that deal with memory and remembering or function as memory devices and draw connections between the first acts of *art*-making and contemporary forms of *making* art. By implementing this "meta-historical mode" (Roelstraete, 2009)[2], I visit the furthest temporal and spacial regions of human modernity, looking at the (figurative) stone the moment it hits the water and the last ripples of the effect. I put art dead centre in the evolution of external memory devices, and I introduce speculation to relate both to the chain of events that it engendered (including DNA computing and Artificial Intelligence) and the interpretation of artworks of other contemporary artists, seen from the same *future-past* perspective. By taking a distance and not putting myself in the picture, I strive for *speculative objectivity*. It is a method of (re)combining existing knowledge and drawing surprising conclusions due to unconventional interpretations and rearrangements of theorems and conventions.

The visual intermezzos in this chapter, containing an overview of the evolution of external memory devices and examples of them as artworks, are built up as a *chaine opératoire*, paraphrasing French archaeologist and paleoanthropologist André Leroi-Gourhan. This notion of technology as the science of human activities is an interdisciplinary subjective approach to artifact analysis, neither linear *per se* nor chronological, to come to a multidimensional understanding of the artists who made the memory devices and the society they are a part of. Since the concept of *chaine opératoire* is based upon the analyst's personal experience and intuition, which is also one of the main criticisms, it is exceptionally useful in the context of this artistic research project because of the parallel with the equally embedded phenomenological ontology of art, both in the process of conceiving, making and interpreting. The visual connections that are made by confronting different memory devices with each other and with works of art, crossing and negating both (chronological) time and

[2] Belgian curator and writer Dieter Roelstraete introduced the 'meta-historical mode' in his influential essay *The Way of the Shovel: On the Archeological Imaginary in Art*. Fittingly, if I remember well, this text also sparked the project *Matter, Gesture and Soul* of Geir Harald Samuelsen in which my Ph.D was embedded, coming full circle once more.

(geographical) space, offer a meta-perspective on different technological inventions that make use of symbolism and abstraction but implement similar enduring strategies and methods to achieve the same result, i.e., enhanced memory skills.

The third chapter, *Looking Back*, examines what I did and made as an artist between 2020 and 2024 in the framework of my artistic research project and contextualizes my work within a larger contemporary art field. It is designed as a rudimentary art catalog or magazine and written contemplatively, talking in the past tense about what happened during the research period and what kind of milestones and turning points brought me to where I am today. I describe the individual works not just through their conceptual connection to the subject matter of memory but also through the *intra-actions* of material and maker, or the act of "mattering" in which matter is "not a thing but a doing, a congealing of agency" (Barad, 2007; Barad, 2013). It is grounded in the emerging discourse of New Materialism, the field of inquiry that reintroduced materialist ontologies around the turn of the last millennium, also known as the material turn. I look at the use of matter, both in my work and that of other artists, as a particular and potential carrier of individual but also societal memory. This chapter is an overview of my artistic outputs during my Ph.D. project and formulates memories of how they came about. I introduce the many people who were involved or played a part in the making or thinking process, and I embed it in the larger research project *Matter, Gesture and Soul* in which my Ph.D. was rooted.

The fourth chapter, *I Forgot …*, is the most artistic and poetic approach towards memory and remembering and, simultaneously, the most personal and autobiographical part. It is inspired by Joe Brainard's book *I Remember* (1970) and sums up everything I forgot in an endless chant or lyrical loop. The chapter is designed as a poem or a mantra. It is written from the I-perspective (I forgot …) and encompasses my whole life, starting with my first mental childhood memory, which I forgot in the meantime, and ending with my testament, which I remember making but forgot what was in it or even where I left it. It brings the experience of forgetting and remembering within the individual and personal sphere while touching simultaneously upon universal and recognizable properties of memory, namely the inherent and interconnected forgetting.

One of the methods I used to relate to this vast subject matter of the temporal evolution of external memory devices is to imagine myself as a Butlerian "*Histo-futurist*," someone who, "in contradistinction to historians and futurists, extrapolates from the human and technological past and present by researching, archiving, and then working over research materials to speculate about possible futures that might materialize on their foundations" (Streeby, 2018). African-American science fiction writer Octavia Estelle Butler (1947-2006) coined the term "*histo-futurist"* in 1981 in one of her notebooks to describe "her interest in the future of both humanity and technology, without turning her back on the past" (Gueye, 2020).

However, historiography and the so-called "Geology of Mankind" are "privileged subjective spaces" (Yusoff, 2018). I'm very much aware of the fact that I'm a *child of my time* and that my perception and thinking are colored by my gender, my nationality, my upbringing, and the geographical and historical framework in which I'm conducting research as I write these words, which is visible, for instance, through the extensive use of Latin words and the large majority of Western sources. This does not mean, however, that I do not recognize the central place of the African continent in the evolutionary process of achieving behavioral modernity and becoming *Homo sapiens sapiens*. I subscribe to Senegalese historian and anthropologist Cheikh Anta Diop's consideration of ancient Egypt as the earliest

great civilization of the world and that it was achieved by black Africans, who invented complex social systems, iron metallurgy, mathematics, science, writing, and monumental art and architecture (Diop, 1955; Diop, 1959; Diop, 1973, cited by Holl, 1995). This fact, along with many other groundbreaking inventions coming from the African continent, like binary code and symbolic thought, were obscured or erased (damnatio memoriae) from the historical records in an attempt to manifest Western superiority to facilitate the colonial project with devastating and enduring social, psychological and epistemological implications.

Through this research project, I want to ensure that we, as humans, don't forget to remember that we all share an intercultural history and that with this realization comes a responsibility towards future generations. "If we want to build a world of true humanity, we must consider all the levels of human interaction,… [to arrive at] …, a frame of mind, a vivid consciousness of people's belonging to a world society,…" (Holl, 1995). We must carry and confront this intercultural heritage and realize that "inheriting is a task" (Haraway, 2010, cited by Gueye, 2020). We must create counter-histories and keep repeating them to foster alternative futures.

Chapter 1: The Road Ahead

Dust clouds are formed when our 4x4 research vehicle tires roll over the bumpy dirt road when we leave early in the morning for *De Hoop Nature Reserve* in the Western Cape of South Africa. With each passing of a car, including ours right now, the sand is exposed to the sun again, updating its measurable age when it falls down again. This luminescence dating technique was used to determine the age of what is now known as the oldest abstract drawing and the oldest example of symbolic thinking scratched on a piece of ochre, both found in Blombos cave in South Africa. Reading stored radiation levels is a form of geochronology, and the driver of our 4x4, Professor Simon Armitage, is an expert in luminescence dating. The process is as much poetic and subtle in a clever way as it is brutal and blunt. He slams a tube horizontally in a stratigraphic layer of interest and pulls out the stuffed tube before carefully triple-wrapping it in black bags that keep any light out. This is the moment archaeologists, who usually work with a brush to avoid damaging any possible interesting finds, close their eyes or leave the cave for a break. It is too violent to witness and goes against everything they learned NOT to do while excavating.

Luminescence dating in Blombos cave, South Africa. (photo: Maarten Vanden Eynde, 2023)

Back in the lab, he removes the tube in a dark room and separates the sand from both ends of the tube from the unspoiled samples in the middle. By hitting individual grains of sand with a light beam, he can determine the age of that layer because if it is untouched and all the grains proved to be simultaneously exposed to light, all the items found in that layer date from the same period. It's an irreversible process, which can only be done once for every grain of sand as it fast-forwards its internal clock. When you read it, you rewrite it. There is no way back. Light doesn't lie.

The grains of sand represent the exact moment that time was read from their internal memory in a lab until they are thrown out, and another car passes and updates the sand again. The extensive sand library that Simon has kept since 1999 is thus as much a chronological database of his luminescence dating measurements as a repository of proof of the age of numerous layers of sand he investigated worldwide. I'm writing this down while a rare meeting of oncoming traffic brings a dust cloud our way, covering the road and our vehicle entirely. All of us are blinded by the sand for a while, unable to distinguish the road ahead until the dust settles, and we see the sky again. We taste time between our teeth.

Driving through the arid landscape of molten history, we pass by abandoned Dutch colonial settlements spread out over the landscape like stone tools in a cave, a bit everywhere and nowhere at once, with some occasional clusters. I'm trying to pen down my thoughts while being smacked around from left to right and front to back, and I can't help but think of the similar process I'm going through while doing my PhD research. We know roughly where we want to go and what we must do when we arrive, but the road to get there is full of surprises, unexpected turns, and delays because of hideous hindrances along the winding way.

The scribbles in my notebook become almost indecipherable scrawls. The more rocks on the road, the more abstract the writing becomes. And when deep puddles emerge in the beaten track, it's easy to get stuck, as did many passersby before us, gradually making the pits deeper and deeper. A new path must be made or taken to advance and make way, leading to new obstacles while avoiding old ones. Some paths are so overgrown that they nearly stop the car in its tracks. Someone was here before, but that was a long time ago, and it is clear that no one took this path for a very long time. Was it a dead end, or did people follow a different, more accessible path at some point and never cared to look back and revisit the unused or less-used road? My hand and mind struggle to work together as I navigate this sandy sea of symbolic thoughts. Is this the right way? Did we pass the midway point of the journey already? Will it get even rougher, or did we leave the toughest stretches behind us?

When we are almost at the final destination, or at least until we need to abandon our 4x4 and continue by foot, there is hardly any visible road left.

Maarten Vanden Eynde geared up for the descent into the abyss of deep time. (photo: Zarko Tankosic, 2023)

Arrival at the coastline in De Hoop Nature Reserve. (photo: Zarko Tankosic, 2023)

Low-hanging branches and thick trees knock off some parts of the sturdy car, and we need to get out to collect the debris and assess the damage. Humongous red ticks, the size of a fingernail, are crawling over the car. Before they get on our bodies and we take them with us, we quickly jump back in the car after collecting the broken snorkel. This chimney-looking part of the car, including a chimney cap to protect it from leaves entering or birds nesting, ensures the air coming into the engine is clean and cool and allows the car to be submerged underwater up to a certain degree or depth, of course. So it's pretty vital we replace it after our return. For now, we just need to keep breathing. Deep scratches also scarred the paint and the car's windows and became proof of our passage. It will need some serious polishing to be returned to its initial state, and some scratches might leave permanent scars. But we can't stop now; we're almost there. We haven't come this far to give up. Just a last little push through the bush… and then we see the open ocean in front of us. We made it!

After a short break, we pack our gear and continue the journey without the 4x4 that took us this far. The sun is out, the sky is blue (filled with puffy Magritte-like clouds), and the sea is rolling up and down over the rocks that litter the boulder beaches below the cliff we need to descend to get to our destination. I feel privileged to be allowed to be part of this scientific journey of discovery, where many research interests and specialties intertwine. SapienCE, the Centre for Early Sapiens Behaviour, is the organizer of the research project that, for more than 30 years now, aims to increase our understanding of how and when *Homo sapiens* evolved into who we are today. Next to British geochronologist Simon Armitage, who officially became the new co-director of SapienCE during our trip when a satellite passed over and delivered the message, there is also Serbian archaeologist and project manager of SapienCE, Zarko Tankosic, and French paleo-climatologist Jenny

Maccali, from the Department of Earth Science at the University of Bergen in Norway. Being a Belgian visual artist myself, I feel this is the right kind of international cross-disciplinary company for a gentle jump into a symbolic abyss. Oh, and of course, there are also snakes and scorpions…

We are all obliged to wear protective snakebite gaiters with no exceptions since we are too far away for any immediate rescue operation. They look like the weird feet covers of Dagobert Duck and make a floppy waggle sound when walking. On top of that, they insulate exceptionally well, so when we can finally remove these artificial leg warmers, we look like we all waded through a river at the same crossing. But we're all in it together, and shared discomfort is half discomfort.

When we walk, we don't talk much. We look down for snakes and scorpions and try not to fall over loose rocks or off the cliff. My mind is working overtime, trying to make sense of everything we see around us. It feels strangely familiar as if some part of my DNA has been here already, and I remember it. Or is that my imagination? Of course, the landscape changed over time, but walking in line with four people covering each other's tracks by stepping on the void of the footsteps in front makes me feel like we were here before.

Wiggle, waggle.

Yesterday, we sat in Blombos cave, staring at the result of 30 years of excavation in a tiny space of 4 x 4 meters. One needs to crawl in on all fours before descending a small ladder into the pit, the place where it all happens. Some sandbags demarcate the designated sitting area and protect the floor. A merely two-meter-high wall represents 100.000 years of human occupation of the cave, with bones and shells sticking out of the clean-cut sections, sprinkled with hundreds and hundreds of white plastic labels demarcating the different stratigraphic layers. CGAB, CCC, CFA, CIA, CIBh2, CN/CO. There is a logic in the chaos of labels, a purposeful pattern that works reassuringly. Someone knows what it means.

Tackling complex processes, like human cognitive evolution or the invention of symbolic thought and expression, requires a multi-angle approach, mixing and merging multiple specialisms and implementing ideas and insights from various experts, including image makers. Only then can we achieve some understanding of these larger-than-life conundrums. Artists are extensively trained in speculative reasoning and imaginative deducting, which may be why we are sometimes invited to be part of these research projects. We function as catalysts, as experts on prolonged perception.

Wiggle, waggle.

Closeup of the stratigraphic layers inside Blombos cave (photo: Maarten Vanden Eynde, 2023)

The digging pit inside Blombos cave (photo: Maarten Vanden Eynde, 2023)

Being in the cave, in front of this giant crumble cake with thin layers of alternating multi-colored sand stacked like a tiramisu, is intimidating and overwhelming at the same time.

Are we the icing on the cake? The last layer?

The archaeological work is done horizontally, slowly working downwards using a brush and a scraper, removing grain after grain in designated plots of 50 x 50 centimeters. But after years of scraping and brushing, the result is vertical. No one in this cave before us has ever seen past time like this, and maybe no one should. This sneak peek through human history is not how we are supposed to see time, let alone experience it. It is too overpowering and bewildering to be confronted with such timescales compressed to human size. It is roughly the same height as my body if I could stand up, but the overhanging ceiling keeps me on my knees. It's impossible to internalize the feeling in my body, which is too small and too big simultaneously. (I remember experiencing this simultaneous shrinking and expanding as a kid when I was lying in bed alone and closed my eyes, ominously called dysmetropsia, or more poetically the Alice in Wonderland syndrome, or AIWS).
Print a white label!

I'm falling into an ontological rabbit hole: is this why we started communicating, as humans, to figure things out together? By sharing the few pieces we carry with us of this gigantic puzzle of comprehension, we get a better overview and a richer, kaleidoscopic image of the world around us. When we share our inner visions or hallucinations of reality, we create a universal fantasy together, or at least something we can agree upon.
Do I have an existential cave crisis?

People had dinners here; they made tools, knapped stones, ground ochre, dressed up, slept, made love, gave birth, and died—all in the same cake—for more than 100,000 years! It is impossible to relate to this compressed collection of momentums. It feels like I'm not really there, not yet, or not anymore.

I'm having an out-of-body (OBE) experience. A label!

Keep breathing, in and out, in and out…

'I think it's this way,' says Simon, after walking for hours along the coast in the blistering heat. I forgot my fishing hat, so Zarko offers me his spare camouflage-colored baseball cap with South Africa stitched up front above a national flag. Yes, thanks; now I know where I am. I look more like a tourist or a hunter but also feel a bit better.

And then, at last, we arrive at our destination: Bloukrans Cave, a cave that tens of thousands of bats now occupy. It is dark, humid, warm, and smells like centuries of batshit, penetrating straight through our 'COVID-safe' dust masks. Not wanting to take any contamination risks, we dress up in full protective gear before crawling inside through a narrow hole to collect various measuring instruments left there before and install new ones. Some well-hidden plastic tubes containing these measuring instruments were found by monkeys and taken somewhere else. They tasted the plastic cap, judged by the bite marks, and must not have liked it much because they tossed it away and left it.

We drill some core samples in stalagmites to measure climate conditions and changes when early modern humans occupied the caves, which is what Jenny Maccali is after. It feels very violent to drill holes through these ancient old stalagmites, leaving them behind as Tony Cragg sculptures in the making. All in the name of science? Or art? I bend over, recovering just in time from the AIWS and OBE, and use my 20 years of construction work experience (AKA muscle memory) to help smooth out a beautiful core drill sample.

After a breathtakingly intense long day, we return to the car and, with a final waggle, shuffle the sand around once more.

Core drilling stalagmites with Jenny Maccali and Simon Armitage. The masks are worn to avoid bat contamination rather than protect against COVID-19. (photo: Zarko Tankosic, 2023)

Chapter 2: Art as a Memory Device

Inside the human nervous system, there is an embedded biological tendency to reveal geometric visual percepts when undergoing certain external stimuli, like pressing your eyeball, prolonged exposure to darkness or bright light, severe headache due to a head injury or sickness, extreme fatigue, hunger, or lack of oxygen. Everyone sees the same kind of geometrical percepts regardless of age, gender, cultural background, or place of birth. It is a universally occurring feature of the human brain, and since they did not change neurologically, at least not in the last 100,000 years, every member of the so-called modern human family was able to experience the same kind of geometrical shapes. No one could escape them either when the conditions for their emergence were present. The duration, frequency, order, and variation of these entoptic phenomena (meaning that they come from within the eye or the brain cortex) varied depending on various external factors. But it is safe to say that when early humans entered a pitch-black cave and stayed there very long, they would have seen the same thing as humans do right now: dots, grids, zigzags, catenary curves, and meandering lines (Lewis-Williams, 2002). They *saw* or experienced this, regardless of whether they closed their eyes. Humans drew them on cave walls or portable stones while they were *seeing* the visions, or they drew them out of memory after the experience. It is not hard to imagine that the first tangible externalization of mental images, i.e., the first works made by image makers (or artists), were similar geometrical shapes. But when did they give them a meaning? When did they become mnemonic memory devices? Or when did the geometrical shapes become representational for something other than the shapes' reproduction? And if the externalized shapes are mere registrations of pre-existing shapes and forms wired in the neurological mesh of the brain, should they not be considered *figurative* drawings rather than *abstract*? Are they not copies of an existing reality visible under certain circumstances?

By making physical traces, serendipitously or on purpose, of what they saw, humans turned engrams, internal memory traces in the human mind, into “exograms” (Donald, 1991) or external memory traces. Internal memory traces are formed due to a lived experience, such as being in the dark for a long time. External memory traces are formed due to a physical expression of that lived experience. Exograms can thus be seen as the first works of art (or skillfully externalized human expressions). They make the physical transformation of matter, like the scratching, grinding, and mixing of ochre and the knapping of stones, a part of the rich spectrum of communication techniques. Humans have always felt the evolutionary need to learn to communicate emotions, thoughts, and threats by mimicry and repetition to remember them, emphasizing the advantages of living as a herd animal. The Canadian neuroanthropologist Merlin Donald called it the “exographic revolution” because of the resulting hybrid memory networks that significantly augment the working memory capacity. Humans could remember and revisit many more experiences and use a more extensive *best practice* collection of causality to navigate constant uncertainty, individually and as a group. This hybrid memory network can be called “Extelligence,” instead of Intelligence, which refers only to knowledge and cognitive processes within the human brain (Stewart & Cohen, 1997). Extelligence is the sum of all the external cultural capital available to humans, from tribal legends to fashion magazines and nursery rhymes to computer code. British philosopher Andy Clark and Australian philosopher David Chalmers called it “The Extended Mind,” or EMT (a label, anyone?) as it became later known, in their groundbreaking paper with the same title (Clark & Chalmers, 1998). They started with a simple question: ‘Where does the mind stop and the rest of the world begin?’ before assembling and presenting evidence for the non-existing frontier between the external world and the internal brain. American science writer

Annie Murphy Paul took it even a step further in her book with almost the same title, claiming that most of the human thinking process does not happen within their brains at all (Paul, 2021). It comes about through sensing the world, moving through it, and making gestures to explain it to others.
Bridging the mental gap between the inner body experience of sensing and thinking individuals, on the one hand, and the external world, including other individuals, on the other hand, was probably the most significant accomplishment in human evolution. This chapter's key concern is how this happened and what kind of role art (the entire cultural history of human expression) played in this mind-boggling process.

Homo Mimeticus & Homo Symbolicus

Humans use their bodies to communicate all the time. Next to physical expression in the form of movements (like gestures, charades, mimicry, and dance), they learned and slowly mastered verbal expression in speech (like making rhythmic sounds, *musicking*[3], chanting, and singing). These powerful memory systems and techniques represent the first steps in the externalization process of thoughts and emotions and were most likely used long before the invention of transformed matter as a symbolic memory device. When humans speak, according to research by American professor Justine Cassell, director of the Human-Computer Interaction Institute at Carnegie Mellon University in Pittsburgh, US, "gestures always occur just before the most emphasized part of what you are saying" (Goleman, 2013; Morrel-Samuels & Krauss, 1992). Physically, humans are communicating before they open their mouths. Human infants also communicate through gestures before developing speech, and even blind people use gestures when talking to other blind people (Iverson & Goldin-Meadow, 1997, 1998). This means that somewhere in the neurological build-up of the human brain, gestures play a crucial role in communication and information exchange. Memories are recalled more accurately when accompanied by gestures, and when someone explains new information to someone else, gestures significantly improve transmission and recollection (Dargue et al., 2019; Clough & Duff, 2020; Genova, 2021).

For a long time, physical transformations of matter were an integral part of remembering, and their functionality was interlocked with the hominin body performing certain gestures, releasing knowledge in the process. The knapping of stones, for instance, which started about 3 million years BP (Harmand et al., 2015), could also be considered as possible *musicking* and remembering gestures whose prowess and purpose are found in the rhythmic and repetitive process of making rather than, or in addition to, the finished result. Whether or not "Homo Mimeticus" (Lawtoo, 2022), or hominins before them, had mental templates of what they wanted to make is irrelevant here because the primary purpose is to be found in the repeating physical gesture itself and whatever sounds and potential information exchange it engendered. It is clear, however, that they had intentionality; they knew what they wanted to do, maybe more than what they wanted to make. Using repetition and mimesis for several millennia, in this case, they created toolmaking traditions consisting of direct and indirect percussion knapping and gradually following the laws of exponential growth by evolving faster and faster; they improved their functionality and complexity. The stone tools became "archives" of their own function, according to French philosopher Bernard Stiegler, provoking the first sparks of conscious reflection in humans. The materiality of the stone tools acted as external markers of a past

[3] *Musicking* is used in the context of this text to echo the proposal of New Zealand-born musician and author Christopher Small in his book with the same title (Musicking, 1998) to highlight music as a process or a verb rather than an object or noun.

need, making conscious interiority emerge by incorporating this nonhuman exteriority (Stiegler, 1998, cited by Bennett, 2010). According to American archaeologist and paleoanthropologist John F. Hoffecker, bifacial stone tools are the earliest known examples of thoughts expressed in material form. As a result of this human capacity for externalized thought, "the mind transcends not only biological space (the individual brain) but also *biological time* (the lifespan of the individual)" (Hoffecker, 2011).

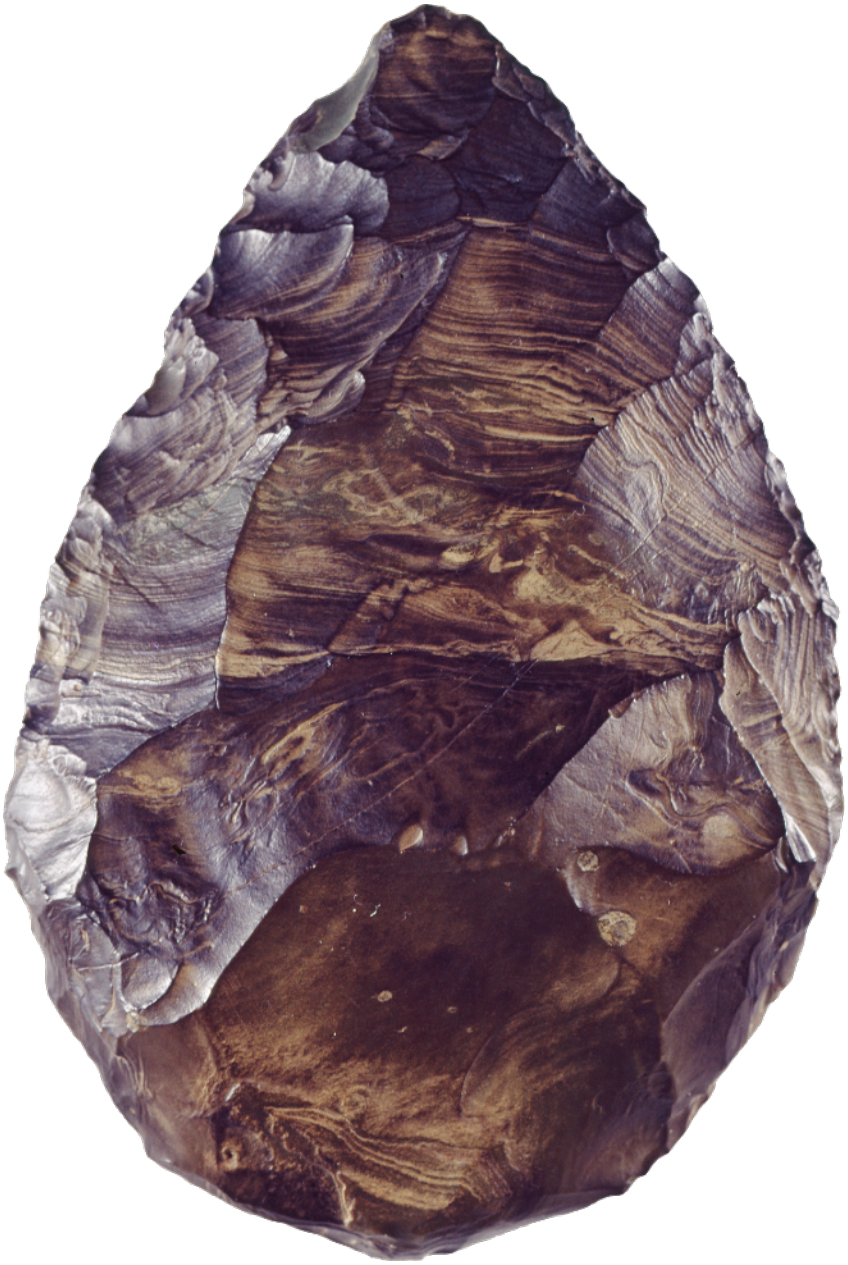
The physical gestures of knapping stones were a necessary part of the information exchange or the learning experience, much like writing, which was vital for humans in learning to read. Toolmaking and language, or the hand functions and the vocal tracts, share overlapping neural circuits in the human brain (Holloway, 1969; Hewes, 1973; Kimura, 1979; Pulvermüller & Fadiga, 2010, cited by Stout & Chaminade, 2012; Petitt, 2023). This is what Korean neuroscientist Hyunjune Sebastian Seung called *Connectome,* emphasizing the interconnectivity of neural functions in different brain regions. He built further on the basic Hebbian synaptic plasticity theory, claiming that "Neurons that fire together, wire together" (Hebb, 1949, city by Seung, 2012). For instance, the neuronal connections that fired together through a combination of visual, auditive, and haptic expressions are strengthened so that those neurons become activated again during memory recall.

The action of physically writing a letter, a symbol, or knapping a stone flake activates the premotor cortex in the brain, which plays an indispensable role in the spatial and sensory guidance of movement, the understanding of actions of others, and in using abstract rules to perform specific tasks. Simply put, when one does it, one knows it. The premotor cortex sets in motion a network of activations in other parts of the human brain, eventually leading to the neural network used for reading (James & Engelhardt, 2012). The merging of motor planning, control, and execution depends on so many different things, ranging from selecting pressure points, distance, rotation, speed, overview, and foresight, that mastering them demands endless repetition. Most humans struggle for a long time before being able to write individual letters. However, once this process is automated, the specific and subsequent movements needed to form each character no longer change. That's why finding a match during a forensic handwriting examination is relatively easy for a well-trained human examiner.

To remember the correct spelling of a word (was it with one t or two tt's?), humans wrote it down. Usually, when the writing gesture is started, the muscle memory takes over, and without thinking too much about it, the word re-emerges correctly. Making handwritten notes in class during a lecture at school helps to retain information much longer and more accurately for the same reason: it is accompanied by movement. When memory fails altogether, and humans can't come up with a name, a word, a place, or a person, rapidly hammering fingers on a table or slapping any surface, including their own body, with their hand seems to help to regain connection. (Ah damn, what was it again? … tap, tap, tap, tap, tap,…. ah yeah!…). This physical gesture often results in magical information retrieval by allowing the premotor cortex to reconnect with the neural network of the hippocampus, the neocortex, and/or the amygdala, depending on the nature of the memory. Could this be a rusty remnant of the old-school stone-knapping courses ancient humans gave each other?

Mimicking sounds produced while knapping stones might, as a collateral consequence of the cognitive revolution, have led to the first conscious linguistic experiments. In the southern part of Sub-Saharan Africa, an area connected to the emergence of modern humans or complex behavior by introducing symbolic gestures, silcrete artifacts, cores, and flakes, are omnipresent. All the Khoisan

languages, still spoken in the third millennium in the same area, used click consonants as part of their communication pallette. Notably, the alveolar clicks ⟨!⟩ and palatal clicks ⟨ǂ⟩, sound eerily like the knapping of silcrete rocks. It makes one wonder whether the sounds were used to (re)enforce a specific meaning and to repeat a message or story rhythmically. Are the clicks the last remainder of a communication technique that uses the sounds of different materials hitting each other, like a musical score or rhythmic dance? Could this explain why most silcrete artifacts don't seem to have been used after completion, or why some are so big and heavy they could not have been used as an axe at all?



Silex stone tool from Adrar Bous VI, Ténéré Desert, Niger

Was their function temporal and predominantly related to the making process so that they had to be remade once finished to regain functionality? Were they just byproducts of a conversation or information exchange? Can this explain why they were often found very far away from where they were made, making them seem part of an elaborate exchange system that included ochre from various sources, for instance? Suppose memories were attached to a particular silcrete artifact related to a meeting, shared event, or information exchange, which is why they were not used as an axe or meat scraper, can they be considered the first external memory devices, as Stiegler and Hoffecker also proposed?

Replica of *The Great Star of Africa*, the largest piece cut from the Culligan,
is a 3106-carat diamond found in the Premier Mine in Pretoria, South Africa, in 1905 © Diamondcz

Since humans have become so accustomed to physical memory systems, they still use them unconsciously when they want to remember something. Think, for instance, of how rhythm or sound is used to remember number sequences, like phone numbers, login codes, or passwords, or how repeated gestures are used to practice the perfect execution of a known move, like chopping wood or hitting a golf ball. The same can be said about synchronized action by multiple people when counting in combination with repeated (aiming) movements is practiced. Imagine two people throwing something heavy and letting go simultaneously in the right direction: one, …, two, …, three, go! Was it on three, or after three?! These forms of expression always depend on the physical presence of a body; they are elusive and intangible. They must be repeated and reconfirmed constantly (next to being performed well — on three or after three?) so as not to be forgotten.

Symbolic culture emerged fortuitously as a perfect solution for the need for more elaborate mnemonic techniques next to repeated physical gestures and sounds. Personal ornaments, like strings of beads and engraved and pierced shells, for instance, or marks made on the human body, like ochre stains, scars, and tattoos, are examples of symbolic behavior because they imply marking of personal or group identity (Wadley, 2011). They are examples of modern cognitive behavior and define "Homo Symbolicus" (Henshilwood & d'Errico, 2011). It was, however, only when symbolic behavior became detached from the human body that the full potential of symbolic culture materialized and led to a wide variety of artistic human expressions. Subsequent examples of artistic and symbolic behavior discovered in sub-Saharan Africa include standardized formal lithic tools, shaped bone implements, and the deliberate engraving of abstract designs on pieces of ochre (Henshilwood & d'Errico, 2011; Straffon, 2019). They helped to overcome the limitations of having only one body.

At the same time, they formed the first steps in making a larger mind, a mental library of sorts accessible by many and surviving after the death of individual contributors. It is an endlessly growing entity of collective knowledge, "extelligence" (Stewart & Cohen, 1997), or "extended mind" (Clark & Chalmers, 1998), supplementing the limited powers of the individual embodied brain. Something like an "external memory field" (Donald, 2002), on which, according to American philosopher and cognitive scientist Daniel Dennett, human experiences can be "offloaded" (Dennett, 1996). Like a snowball, this "social memory of enormous proportions" (Säljö, 2012) continued to roll and roll, adding more material to its core as it moved forward in time. Some flakes fell off along the way and might be lost forever. Others were reinvented, picked up again, and added anew, temporarily or permanently, covering older ideas, concepts, customs, or other cultural traits and habits. However, the essential notion of a functional *mind of many*, condensing and preserving shared human experiences over time, is never lost, at least for as long as humans are around.

Ochre's Razor

Ochre was the first pigment used by hominids about 500,000 years BP, starting in South Africa. It became habitually used throughout the whole African continent around 140,000 years BP, roughly coinciding with the emergence of *Homo sapiens*. What the ochre was used for is uncertain, with speculations ranging from sunscreen, mosquito repellent, hide tanning agent, an ingredient in compound adhesives, medicine, and body decoration (Lips, 1947; Wolf et al., 2017; Wadley, 2005a; Wadley, 2005b; Wadley, 2011; Rifkin, 2011). But it is clear that it already occupied an essential place in the daily life of early humans when they became 'modern' because of its widespread occurrence

close to other cultural artifacts, often far away from the location of origin, and because of the many different traces that were found on the ochre itself, indicating a variety of use. Intensively ground pieces with three or more facets converging to a point are often called “crayons” (Henshilwood et al., 2001). The most spectacular finds have been made recently in Blombos cave in South Africa. They include polished and engraved pieces of ochre, one with a distinct crosshatched drawing, looking almost like a stamp (Henshilwood et al., 2009), and so-called “ochre toolkits,” consisting of abalone shell containers and appliances that can be interpreted as bushes or mixing sticks (Henshilwood et al., 2011). Also, in this case, the human body is central to the externalization ritual involving ochre. In the first instance, the body functioned as a canvas, becoming one with the medium, and later, it became the engraving and drawing image maker, or artist, by itself. Even today, ochre is still used in many artistic media worldwide, from drawing and painting to ceramics and even theatre and performance. This makes using ochre as a pigment for artistic expression the oldest and longest-lasting tradition in art history[4].

Ochre sources near Blombos cave, South Africa (photo: Maarten Vanden Eynde, 2023)

Gradually, by introducing symbolic representation techniques, like abstract/figurative line drawings or colored dots, often made with ground ochre, the communication variability grew exponentially, instigating what evolutionary anthropologists call human (behavioral) modernity. The symbols were used on the body to enhance bodily expression and on other nonhuman surfaces like stone, wood, and hides. Later, they were supplemented by carved stones and bones, knotted strings, and pierced shells, and slowly but surely, the memory devices became detached from the human body. Individual artifacts could be looked at, read, exchanged, and revisited by multiple people who did not have to

[4] From the British painter Terry Frost to the Dutch-American painter Willem de Kooning, and from the British-Guyanese visual artist Ann Mary Gollifer to the Honduran textile artist Adrian Pepe, they all continued the traditional ochre use in their art. The American artist Heidi Gustafson is even called an ochre-whisperer, not in the least because she is known to speak to ochre directly, but also because she was able to create a working sanctuary of over 600 different ochres and earth pigments from planet Earth.

be in the same physical space as the object the whole time. They could be left behind somewhere and remain hidden for a while, but at the same time, they could also be taken and kept close during travels or be passed on to others, even after the death of the original maker. In a way, they were getting or claiming their own life; i.e., their agency grew unprecedentedly, and to a certain degree, they became *alive*. At the same time, interdependency grew exponentially; it became impossible for humans to live without external memory devices and vice versa. Humans and things became "dynamical interfaces," and their cognitive life can, in retrospect, only be understood "in terms of mutual permeability, binding, and structural coupling" (Malafouris, 2013).

Once Pandora's box of material brain extensions was opened, there was no way back. All the subsequent inventions made throughout human history relating to external memory systems and/or devices to enhance direct and short-lived communication and secondary and increasingly intergenerational communication are meant to remedy the fallible and unreliable human brain. "The symbolic universe has ensnared us in an inescapable web," according to The American neuroanthropologist Terrence William Deacon. "Like a 'mind virus,' the symbolic adaptation has infected us, and now by virtue of the irresistible urge it has instilled in us to turn everything we encounter and everyone we meet into symbols, we have become the means by which it unceremoniously propagates itself throughout the world" (Deacon, 1997, cited by Lent, 2017). To a large extent, symbolic behavior came to structure and steer human lives 24/7, bringing about the values that drive collective behavior (Lent, 2017).

Producing material patterns and symbols as communication tools was a true game changer, and the testimony of their triumph and longevity is visible throughout human cultural history, from weaving and dying patterns to ceramic decorations, all the way to the current use of symbols like # and the use of binary code in computer programming. Many theorists insist that this defines humans and separates them from other animal species. Humans turned internal images, or hallucinations, into external technologies, becoming *modern* humans. As for when that occurred, this "Transition," "Creative Explosion," or "Great Leap Forward" as it is often called, is still debated and contested, but considered here as something that happened between 150.000 BP and 70.000 BP instead of 45.000 to 35.000 BP as propagated until the beginning of the 21st century, and geographically arising in Africa instead of Europe, correcting historically persisting Eurocentric tendencies. It should also be regarded as a slow up-and-down scaffolding process, full of trial and error, remembering but also forgetting, instead of one eureka momentum. There is no such thing as a "sapient paradox" (Renfrew, 2007), referring to the puzzling long periods of stasis between anatomical modernity and remarkable life-changing revolutions like the inventions of symbolism or the rise of agriculture. American paleoanthropologists Sally McBrearty and Alison Brooks, and many others after them, provided enough evidence to challenge the Eurocentric "rapid-evolution" theory and proposed a more gradual, long, and sporadic piecing together of modern behaviors originating in Africa (McBrearty & Brooks, 2000; Straffon, 2019). Other humans objected to using the term modern altogether, rejecting the idea of a fixed and stable speciation event marking the emergence of "anatomically modern human intelligence" because of the constant change that an intrinsically plastic human brain undergoes (Malafouris, 2013). Within his *Material Engagement Theory*, the Greek-British cognitive archaeologist Lamros Malafouris propounded on the "metaplasticity" of the brain as the hallmark of human cognitive evolution. British archaeologist Steven Mithen called it "cognitive fluidity," emphasizing the connections modern humans could make "between the domains of technical, social, and natural history intelligence" (Mithen, 1998).

Regardless of how this *neuroplasticity* and the resulting creation of artifacts and memory devices are interpreted, evolution takes time and often works as a meandering string, moving one loop backward and jumping two loops forward or the other way around. "Humans are intrinsically loopy creatures," according to British philosopher Andy Clark, and they "benefit from being rooted between internal and external modes of cognition" (Paul, 2021). One ochre crayon doesn't make an art supply store. And one sharp teardrop-shaped stone tool doesn't make a hand-axe. So, instead of a "finished artifact fallacy" (Davidson & Noble, 1993), a more bottoms-up understanding is recommended, where complexity is attained by repeating and looping simple operations. Australian roboticist Rodney Brooks called it "Cambrian Intelligence" (Brooks, 1999), embracing a *longue durée* evolution of cognitive intelligence while recognizing the shoulders of hominin ancestors on which all humans stand.

Engraved ochre from Blombos cave, South Africa (photo: Stephen Alvarez) and Nokia 3310 cellphone.

The Art of Association

Artistic expression, or making physical traces, is a form of permanence of prolonged perception. Images, visions, and hallucinations are perceived internally and expressed externally. This leads to experiences through the senses, which are stored inside the human body. The brain uses these experiences to predict what is *out there* in the world and how to react. New signals from the senses operate as registers of prediction errors. Perception thus happens both from the outside in and inside out, and navigating this perceptual conundrum can be understood as "controlled hallucination." The French historian, critic, and philosopher Hippolyte Taine first introduced the notion of hallucinations to describe external perception: "So our outer perception is a dream from within, which lies in harmony with things outside, and instead of saying that the hallucination is a false external perception, it must be said that the external perception is a true hallucination" (Taine, 1870). According to Taine, "there is no contradiction between imitation and expression, truth and feeling. Art is both representative of reality and expressive of personality. The author expresses himself, his particular view of the world, and thereby depicts the world around him and penetrates into the essence of things" (Wellek, 1959). In a sense, humans are hallucinating all the time. They call it reality when they agree about their hallucinations (Seth, 2021). Some humans are more susceptible to hallucinations or have a greater imagination to use a more artistic lingua. They are more comfortable with the inherent contingencies of fabricating reality on the go.

This live-rendering and projecting of the world mean that they are not only reading the world, in the sense of interpreting electrical impulses of the senses but also writing it, as in creating or hallucinating reality based on those electrical impulses of the senses. The world people see around them is being constructed and formed within the human body, making it an individual experience even when communicating about it with others. This is what British anthropologist Tim Ingold called "knowing from the inside" or KFI, insisting on the simultaneity and, to a certain extent, interchangeability of thinking *with*, *from,* and *through* beings and things, not just *about* them (Ingold, 2022). Art is the tool humans invented to bridge the solipsistic agency of reality. It is the physical translation of individual uncertainty, the means to visualize and share experiences and insights. Art is the search for a shared reality.

When descending further in more altered states of human consciousness, entoptic phenomena, or "form constants," as German-American biological psychologist Heinrich Klüver called them, are transformed into iconic forms, i.e., familiar objects from daily life. They merge into one another, creating new forms and shapes. After that, visual hallucinations start to include the one who hallucinates as well, placing the self in a fictional universe where entoptic phenomena are fused with iconic forms and sometimes include hybrid human/animal elements (Horowitz, 1964, 1975; Lewis-Williams, 2002). All these depictions of altered states of consciousness are present in Palaeolithic and Mesolithic cave painting imagery. But what is visible in the outside world, beyond the mental state of darkness? Do similar geometrical shapes that are experienced through a stimulated nervous system also exist outside the cave, and can they be seen when not hallucinating? What other natural elements, or iconic forms, are not constantly changing and chaotic and contain abstract, repetitive patterns and symmetrical logic? And when encountering them, did early humans wonder whether others made them before them or whether the natural phenomena were a sign of being *"self-similar"* in a Mandelbrotian sense, equally sentient, together with plants and stones?

There are many examples around that could do the trick and were abundantly present at the time in question. There are clear spirals in the opercula of shells, plants like ferns and the Spiral Aloe (*Aloe polyphylla*), sunflowers, vine tendrils, ungulate horns, pinecones, and weather patterns. Snail shells, for instance, are still the most common African visualizations for infinity, according to Ron Eglash, the American cyberneticist who specialized in fractals (Eglash, 1999).

Opercula shell spiral found near Blombos cave, South Africa (photo: Maarten Vanden Eynde, 2023).

The spiral has inspired artists and many others, including Pelé (Vanden Eynde & Buergel/Prinz, 2021) from the moment that art was invented around 3 million years BP, all the way to the 21st century, from Albrecht Dürer to Vincent van Gogh, and MC Escher to Louise Bourgeois. However, arguably the most iconic and likely longest-lasting artwork involving a spiral is *Spiral Jetty* by the American artist Robert Smithson. As a co-founder of the Land Art movement, he was instrumental in the debate about the role and responsibility of artists in society, which was, according to Smithson himself, related to the sharing of both mind and matter (Smithson, 1968). He was as much a sculptor as a theoretician or art critic and introduced the concept of "non-sites" in opposition to "sites," where the latter refers to an actual site-specific location (where his Earthworks were made for instance), and the first to a representational reproduction of a particular site in a white cube art gallery, or a non-site. This representation could take the form of documentation, photographic or audio-visual, or by showing samples of rocks in a new constellation, like "abstract geology." His stratigraphic interest allowed him to bridge immense distances in time and space while at the same time drawing connections between ancient and contemporary inventions and technologies: "Even the most advanced tools and machines are made of the raw matter of the earth. Today's highly refined technological tools are not much different in this respect from those of the caveman".

He thought of the strata of the Earth as a "jumbled museum" and claimed that "in order to read the rocks we must become conscious of geologic time and of the layers of prehistoric material that is entombed in the Earth's crust. When one scans the ruined sites of prehistory one sees a heap of wrecked maps that upsets our present art historical limits. A rubble of logic confronts the viewer as he looks into the levels of the sedimentations. The abstract grids containing the raw matter are observed as something incomplete, broken and shattered" (Smithson, 1968). According to Roger Caillois, the French author of the richly illustrated *L'ecriture des pierres*, the "archives of geology" even carry the model of what would later become an alphabet (Caillois, 1985). It supplies the material for what would eventually become media and technology (Parikka, 2015), circling (or spiraling) in on ancient animistic belief systems where knowledge and memory have always been present in stones, even without or prior to human presence.

"Rock library" near Blombos cave, South Africa (photo: Maarten Vanden Eynde, 2023).

Stratigraphic layers can yield perfectly straight lines stacked on top of each other. Others create crosshatched patterns when rocks are cracked diagonally to the stratigraphic lines. Sometimes, cracks are square on each other, creating a perfect grid pattern. Did early humans find meaning in those patterns? Were they able to read between the lines? Finnish media archaeologist Jussi Parikka called this double bind between "the materiality of the unconstrained" and "the logic of ordering" the sphere of *mediacultures,* cleverly adapting American philosopher, biologist, and author Donna Haraway's influential concept of *naturecultures,* when she described the co-constituted relationships between nature and culture (Parikka, 2015; Haraway, 2003).

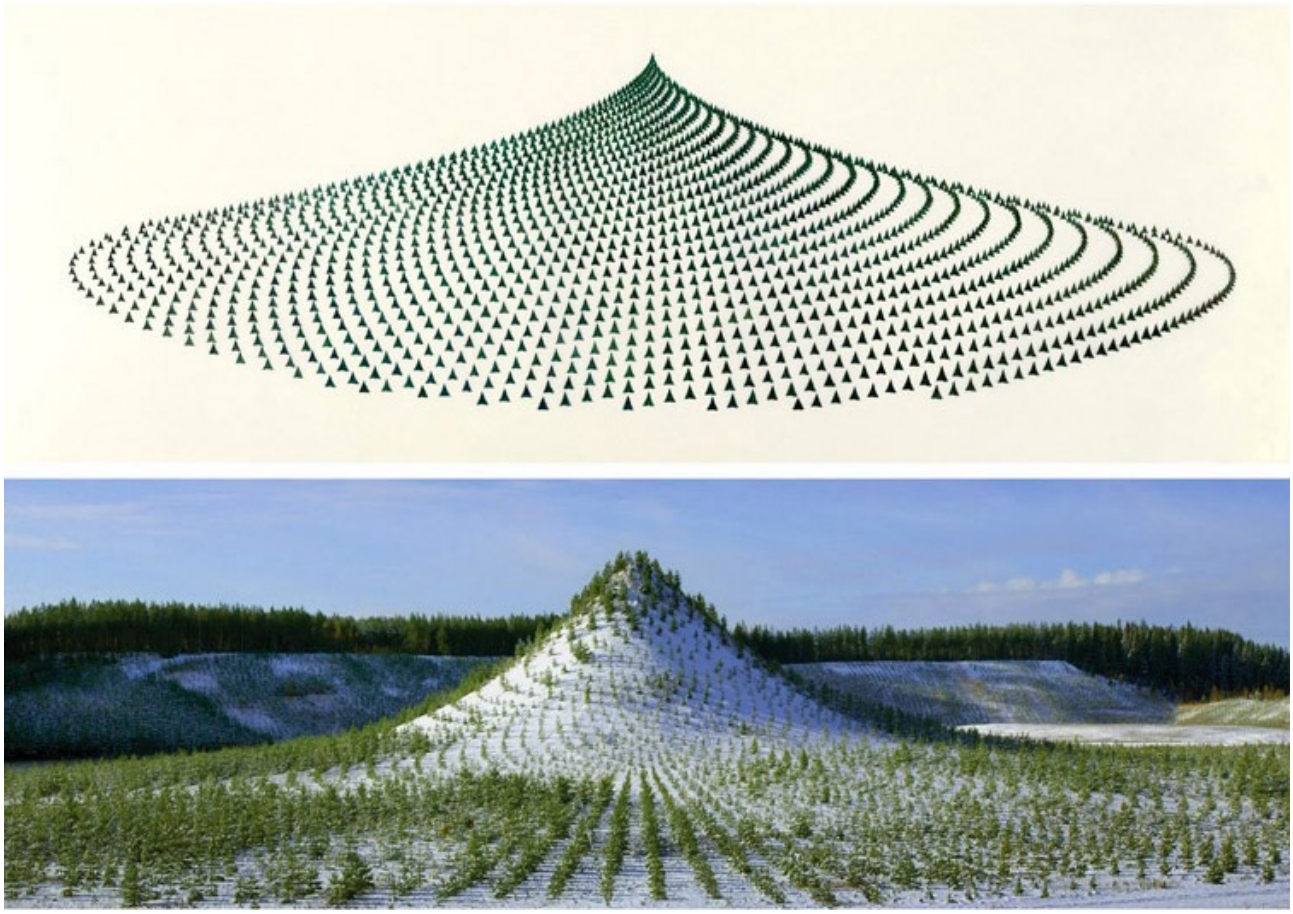
Spiral Jetty and many other of Smithson's land art interventions can be seen as monuments, linking ancient or even natural iconography and symbolism with the industrial picturesque. Salt crystals that,

Robert Smithson, *Spiral Jetty*, 1970. © Holt/Smithson Foundation and Dia Art Foundation/Licensed by VAGA at Artists Rights Society (ARS), NY. (photo: George Steinmetz).

over time, covered the entire spiral located in the Great Salt Lake in Utah were, from the start, an integral part of the work. Gradually, the spiral became submerged in salt crystals, making a link between the macro and the micro and connecting a common flaw in the growth structure of salt crystals when they are creating a screw dislocation movement, like a spiral, around a dislocation point (Smithson, 1972). Are humans that self-perpetuating dislocation point in Smithson's work? Is *Spiral Jetty* a monumental enlargement of tempering with, or dislocation of, the microscopic crystallization process of salt, like an eternal clockwise expansion of time kickstarted by disruptive human intervention?

A less anthropocentric example is *Tree Mountain—A Living Time Capsule,* made between 1992 and 1996 in Ylojärvi, Finland, by the Hungarian-American artist Agnes Denes. 11,000 people planted trees on an artificially created elliptical mountain 420 meters long, 270 meters wide, and 38 meters high, constructed as a land reclamation artwork on an old mining site to cover up previous extraction activities. Everyone who planted a tree was made custodian of the new forest for 400 years by receiving an inheritable certificate that would be handed over for about 20 generations. The pattern used to plant the trees was based on the Fibonacci spirals that follow a sequence in which each number is the sum of the two preceding ones and can be found in snail shells, sunflowers, and pineapples. According to Denes, “The universe contains systems, systems contain patterns. The purpose of the mind is to locate these patterns and to seek the inherent potential for new systems of thought and behavior. Pattern finding is a symmetry operation. It is the purpose of the mind and the construct of the universe. There are an infinite number of patterns and only some are known. Those that are still unknown hold the key to unresolved enigmas and paradoxes” (Denes, 1986).

Much like Smithson, Agnes Denes was a writer first, although leaning more toward poetry and philosophy instead of art critique. She developed a visual language through writing and art making, which she aptly called "Visual Philosophy." Her interventions were more "eco-logical" and temporal than Smithson's, but they shared a similar interest in symmetry, mathematics, crystallography, human insignificance, and, of course, the spiral.



Agnes Denes, *Tree Mountain —A Living Time Capsule*, conceived in 1982, constructed in 1992-96. © Agnes Denes

Connecting the Dots

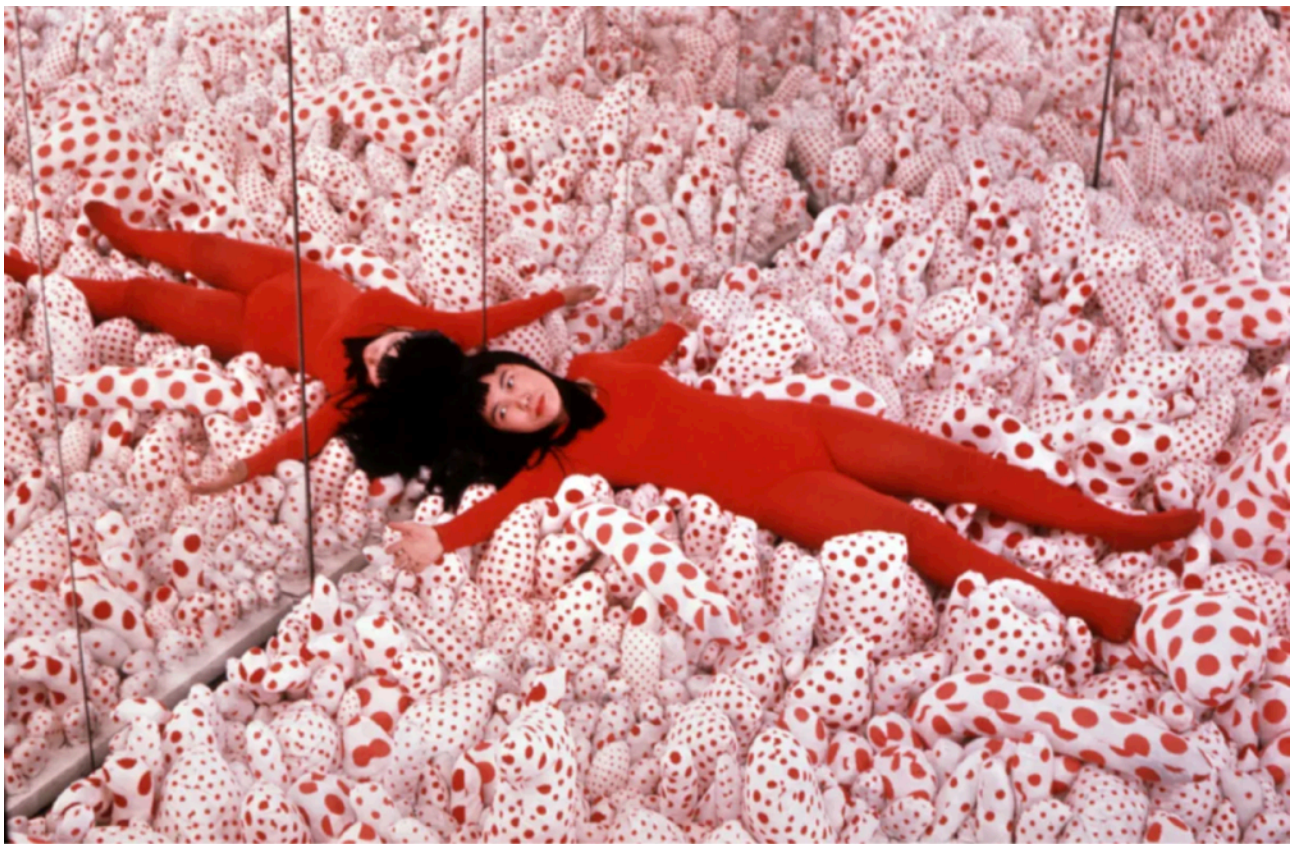
Dots are found on Polka Dot Grouper fish (*Cromileptes altivelis*), the Clown Tigerfish (*Balistoides conspicillum*), sea urchins, fern leaves, butterflies, certain felines, and mushrooms. As with spirals, many artists used dots from the first moment abstraction and symbolism were invented. During the Upper Palaeolithic, dots were used to denote time and mark lunar and wild animal reproduction cycles (Bacon, 2023). They were also used to fill entire contours of animals or in rectangular grids, begging the question of whether they were used as part of a graphic communication system or as an aesthetic cover-up.

In Australia, dots were used to hide sacred and secret stories by Aboriginal people who were stimulated to paint with acrylic on canvas for the first time in the early 1970s by the art teacher Geoffrey Bardon as an alternative to the constantly disappearing sand drawings. When they saw that the stories stayed visible and thus readable to other people, they started hiding certain features by covering or obscuring them with dots. The dot paintings, or the Western Desert Art Movement, as the

Markings in El Castillo cave in Spain. (photo: Dillon von Petzinger)

work by the artist cooperative Papunya Tula is also known, influenced Aboriginal people artists on the entire Australian continent to such a degree that it became known as the origin of contemporary Indigenous Australian art. Artists like Emily Kame Kngwarreye, Rover Thomas, and Johnny Warangkula Tjupurrula became world-famous and caused an international run on new and original works by Aboriginal people. The interest of foreign dealers and collectors alike generated an explosion in production, hastily made copies of dot paintings, and a physical rush of speculators towards where it supposedly all started: a former German settlement community called *Utopia* in the Northern Territory of Australia.

The Japanese artist Yayoi Kusama began using polka dots in her work quite literally due to persisting hallucinations and visions of dots when she was young. Externalizing them repetitively and excessively calmed her down and helped her comprehend human insignificance in the greater scheme of things. During an interview in 1968, the same year that Robert Smithson published his iconic text *A Sedimentation of the Mind*, Kusama said in an interview: "Our earth is only one polka dot among a million stars in the cosmos. Polka dots are a way to infinity. When we obliterate nature and our bodies with polka dots, we become part of the unity of our environment." And just like Smithson, she used a lot of mirrors in her work to emphasize the multiple perspectives enigma of perceived reality.



Yayoi Kusama posing in *Infinity Mirror Room—Phalli's Field*, 1965, Hirshhorn Museum (photo: Eikoh Hosoe).

Cracking the Code

Zigzags can be seen in mountain formations, showy banksia leaves (*Banksia speciosa*), millipedes (*Siphonocryptus zigzag*), viper snakes (*Vipera berus*), the bunya pine (*Araucaria bidwillii*) or monkey puzzle tree (*Araucaria bidwillii*), the zigzag scallop shell (*Euvola ziczac*), lightning, and cracks in dry soil. The oldest human engraving is a zigzag found on a freshwater mussel shell fossil in Trinil, Java, Indonesia. It is more than 500,000 years old, so probably made by *Homo erectus* (Joordens et al., 2014). Based on the extensive research of Polish archaeologist Tomasz Płonkas in *The Portable Art of Mesolithic Europe*, the conclusion can be drawn that zigzag lines are among the most common ornamental elements in Paleolithic and Mesolithic decorative art. Nearly a quarter of the 850 listed portable artworks studied contained zigzags.

In later periods, zigzags were also dominant on human bodies, ceramic vessels, beadwork, clothing, and even architecture. They are used as markers of a difference, a sign of separation or belonging to a specific social group or geographical territory, and they can function as protective patterns of natural origin because they resemble teeth or snakes (Petersen, 2021). And also, in the 20th and 21st centuries, artists used zigzags as a recurring feature. From Alexander Calder's *Zigzag Sun and Crags* to Wassily Kandinsky's *White Zig Zag* and wooden Zig Zag figures of the Bamana people of Mali, Africa. And from Robert Smithson's *Gypsum Nonsite, Benton, California,* or his *Alogon* sculpture series to Alighiero Boetti's *Zig Zag* installations.

Andy Goldsworthy, *Drawn Stone*, 2005. Courtesy FAMSF.

Doris Salcedo, *Shibboleth*, 2007, The Tate Modern gallery. Courtesy of Getty Images.

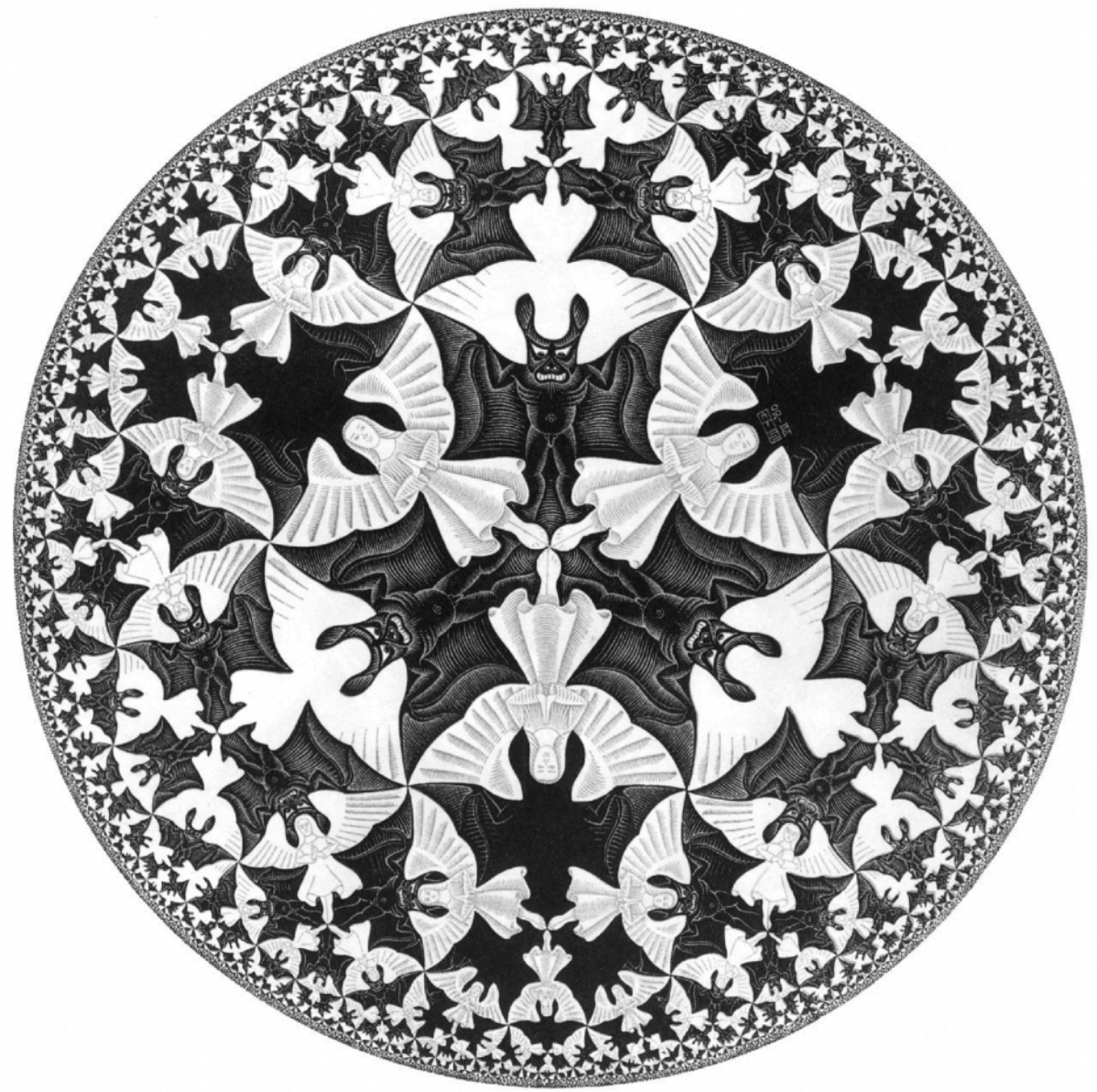
In 2005, British artist Andy Goldsworthy made a permanent installation in the Fine Arts Museums of San Francisco called *Drawn Stone,* a continuous crack running through the museum, to commemorate the earthquake of 1906. Two years later, Colombian artist Doris Salcedo created *Shibboleth*, a gigantic crack in Tate Modern's Turbine Hall that looks like a horizontal void of lightning. The impressive installation embodies a return to the natural occurrence of a zigzag, maybe the first that ever existed, striking down from above. *Shibboleth* epitomizes the historical meaning of a zigzag monumentally and puts it in a contemporary perspective, referencing migration, discrimination, and the absurd creation of borders between nation-states that enforce laws of exclusion based on nationality or socioeconomics.

The title stems from a custom or tradition distinguishing one group of people from another. Shibboleths can be a single word or expression and have been used throughout history in many societies as a way of self-identification, signaling loyalty or affinity, and maintaining or confirming traditional segregation. They were also used to protect oneself or others from real or perceived threats.

Fractal Facts and Fictions

Fractal geometry, pioneered first by Chinese philosopher Cheng Yi during the Song Dynasty (850 BP) and later by French-American mathematician Benoit Mandelbrot in the mid-20th century, is equally visible in natural elements like cloud formations, coastlines, river deltas, and sand dunes, but also in tree branches and most plant leaves. Looking up close, even the design of life itself is fractal, "with cells self-organizing to form organisms, which then self-organize into communities of organisms and ecosystems" (Lent, 2017). Fractals first became a cultural building block on the African continent and are still visible in city planning, architecture, traditional hairstyling, textiles, carving, metalwork, and games (Eglash, 1999). Dutch graphic artist Maurits Cornelis Escher used them frequently in his immersive mind-bending drawings, and the American artist Jackson Pollock implemented fractal patterns after he retreated into nature to escape the hectic city life of 20th century New York to create his calming and awe-inspiring drip paintings, or "fractal expressionism" (Briggs, 1992; Taylor, 1999). The American physicist Richard Taylor made use of computer analysis technology to determine that fractals were indeed at the core of Pollock's paintings, while later on proving that a specific form of fractals found in nature is hard-wired in the human brain to induce stress reduction when visually exposed to these "biophilic" fractals (Taylor, 2021).

According to Jeremy Lent, the enormous range of domains in which fractals could be identified led to an even more profound realization: "There seemed to be certain principles in nature itself that applied across a whole range of disciplines. The traditional approach of science, in which specialists focussed their lives on one tiny patch of knowledge, seemed incapable of recognizing these cross-disciplinary underlying structures in the nature of reality" (Capra & Luisi, 2014, cited by Lent, 2017). The Canadian geneticist, science broadcaster, and environmental activist David Suzuki said something along the same lines in 1986: "By looking at nature in bits and pieces, our understanding of it can only be fragmentary, for nature is not the sum of its isolated parts" (Suzuki et al., 1986). To understand the world around them, humans had to find the underlying patterns, and for many, that is precisely what they did, starting with the first stone tools.



Circle Limit IV, 1960 - M.C. Escher - WikiArt.org

The Patterning Instinct

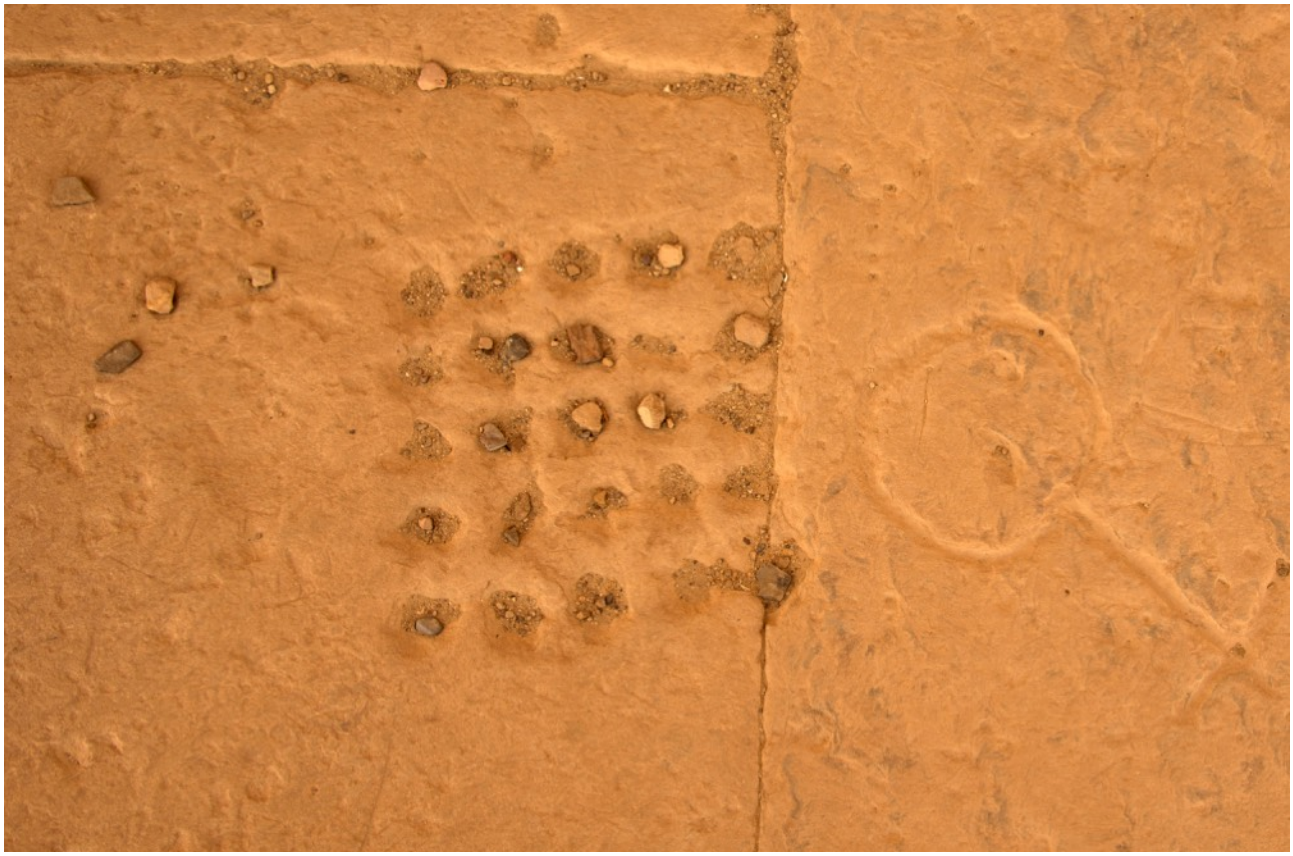
Amidst all the chaos and constant change that surrounded early humans, could these particular graphic patterns, like spirals, grids, dots, and circles, have inspired *Homo sapiens* to strive for order and structure and even see them as guiding principles for survival? Could they have wondered why they saw the same patterns when drawing or carving entoptic images? Was this the trigger that caused them to look for meaning and, by doing so, possibly give them meaning for the first time? The importance of overlapping patterns in nature and the human nervous system is undeniable. Nature and culture are not opposites but rather two sides of the same (nearly) symmetrical biface. They are one. They are *natureculture*. Why else are the same symbols present both in nature and all Palaeolithic and Mesolithic artistic expressions? Graphic writing systems making use of a similar set of signs are found on all continents, as Canadian anthropologist Genevieve von Petzinger put forward, introducing a set of 32 recurring signs that can be interpreted as a rudimentary alphabet before letters were invented (von Petzinger, 2016). Most of the same patterns and symbols are still in use, although they might have changed meaning along the way (think of the #, for instance).

Looking for and finding meaning in or subscribing to patterns is undeniably essential for the symbolic and cognitive revolution that changed humankind for good. Humans are *pattern seekers*, but not in the way British clinical psychologist Simon Baron-Cohen claimed in his book with the same title. He proposed that *if-and-then* patterns are critical to the "Systemizing Mechanism," a *modern* human-specific "brain engine" that fuelled technological inventions emerging around 100,000 BP (Baron-Cohen, 2020). *If-and-then* patterns are essentially basic causal patterns and were first described by British mathematician George Boole in 1854 (Boole, 1854). They follow a simple and standardized logic: "*If* I take a smooth stone, *and* use a tool with a fine blade, *then* I can engrave patterns on the stone" or "*If* I attach an arrow to a stretchy fiber, *and* release the tension in the fiber, *then* the arrow will fly" (Baron-Cohen, 2020). This ratiocination was, for a long time, the binary heart of every computer program, although known in an even simpler version: *if-then* logic, which was inspired by the *all-or-none* law from physiology to describe the functioning of the nervous system, including brains. The Hungarian-American mathematician, physicist, computer scientist, engineer, and polymath John von Neumann modeled the first computers after a human brain, "justifying his choices about how to develop the structure and function of a computer by referring to a biological model" (Cobb, 2020). Only afterwards was the metaphor turned around, looking at the brain as a computer, which would haunt and mislead humans ever since. "Computational logic relies on successful prediction, in which present events suggest likely future events. There's little room for maybes in an *if-then* world," masterfully put forward by Nigerian-American visual artist Mimi Ọnụọha. Human brains did not suddenly become computers that, by default, are wired with a binary patterned *science of reasoning*. "There are *if* statements, but perhaps there are also *maybe* statements, *why not* statements, *now* statements, and everything in between" (Ọnụọha, 2022). Mathematical logic does not apply to the empirical ontology of the human brain, which is guided by inherent subjective interpretations of encountered, imagined, or hallucinated patterns. Instead, mathematics was implemented to strengthen humanity's quest for verifiable certainty to communicate commonality and overcome differences in perception.

"One of the most extraordinary discoveries of modern neuroscience is the uniqueness of each person's functional brain connector (its unique wiring), especially in the brain areas devoted to thinking and remembering something, leading to brain-based biometric authentication which has

security advantages over other biometric data because it is concealed, dynamic, nonstationary, and incredibly complex" (Farahany, 2023). A standardized mathematical methodology had to be invented to establish a functional set of conventions and overcome these unique brain interpretation features to strengthen communication and collaboration.

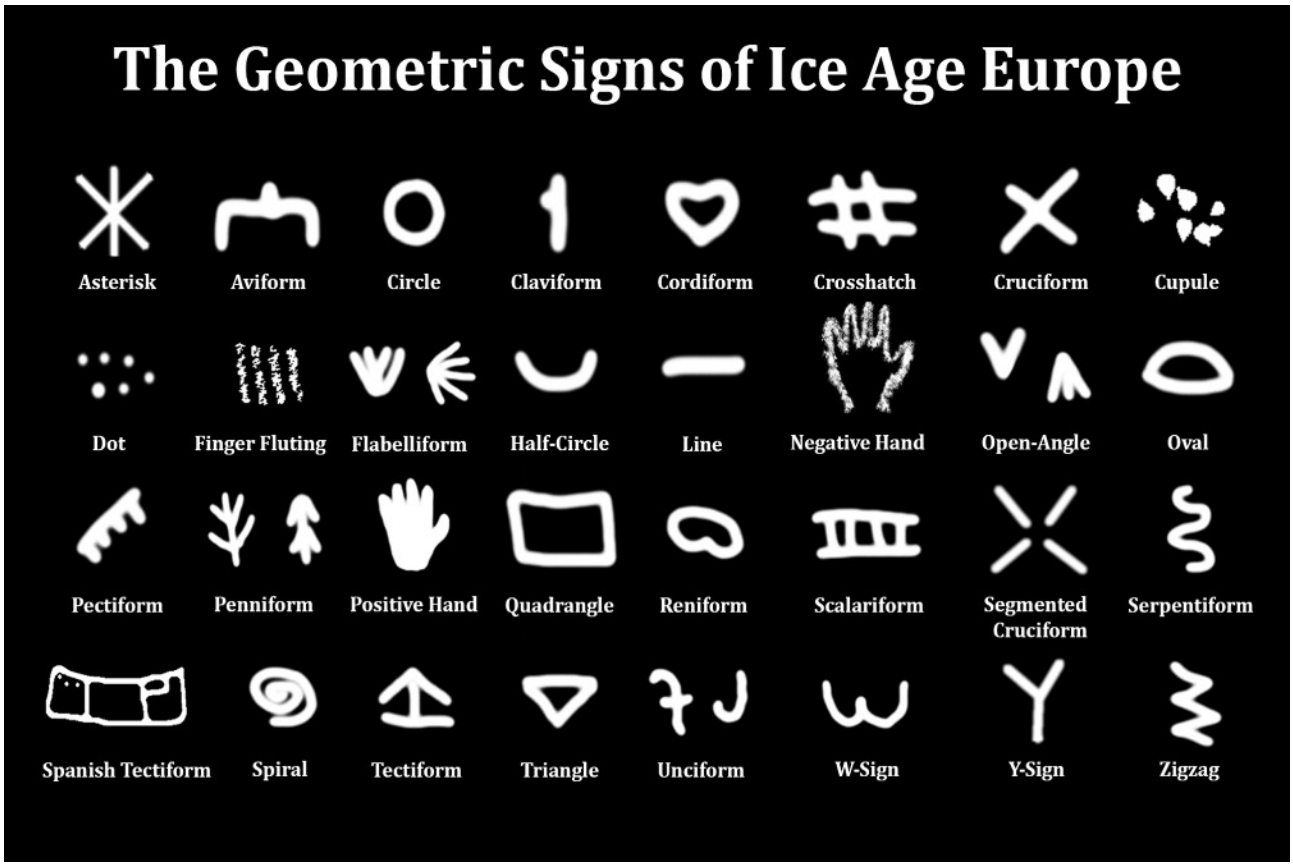
The presence of considerable amounts of pebbles or shells, sometimes decorated and/or perforated, in and near caves, including Blombos cave in South Africa, that contained memory devices (both in the form of portable objects like rocks or bones and as graphic writing symbols drawn or scratched inside caves), opens the possibility to imagine that there is a correlation between them. Before the invention of numbers, counting was made possible by placing and moving pebbles or shells around and following the resulting mathematical logic. This numerical language eventually led to writing, understood as "the communication of specific ideas in a highly conventionalized, standardized manner by means of permanent, visible signs" (Urton, 2003). A grid or structure accompanying the pebbles, either drawn on a rock surface or in the sand, expands the possibilities to use and *read* the outcome. A graphic line drawing without the pebbles would be like looking at a Scrabble game board without the letters; it would not make much sense. For instance, the lines and cross points present on the previously mentioned memory device found in Blombos can be turned into a solar and lunar calendar without too much effort, as the Swiss polymath Franz Gnaedinger proposed. *Why not*, or *maybe*?



Seega game on ElKab Temple of Amenhotep III in Egypt (photo: Bruce Allardice, 2013)

Pythagorean philosophers, for instance, also represented numbers graphically around 2490 BP by using dots, also known as *psiphi* (pebbles), to represent numbers in triangles, squares, rectangles, and pentagons. In Greek, *pséphos* means both stone and number, and in Arabic, *haswa,* meaning pebble, has the same root as *ihsā,* which means a count (of things) and statistics (Ifrah, 1998). The famous

The St. Germain-la-Rivière teeth, France. ca. 16,000 BP (photo: Dillon von Petzinger)



The thirty-two signs depicted in this typology are the main abstract shapes created by early humans living in Europe during the Ice Age. ca. 10,000 to 40,000 BP (Genevieve von Petzinger)

Salamis Tablet, a precursor of countless Abacus variations used until the 20th century, dates from around 2250 BP and allowed for astronomical calculations using just a few lines and pebbles.

Abacus comes from *abaq,* which has two roots in Hebrew-Aramaic, according to Austrian historian of science Solomon Gandz (cited by Day, 1967). The first one is dust, which references ancient dust boards that were erasable calculation platforms and writing surfaces that Babylonians and various scholars used in the early Islamic world. The second root signifies a loop, or a knot, connecting more to the practical use of the abacus as a calculating device. (Day, 1967; Parikka, 2015, Overmann, 2023). These boards or slabs were covered with a "fine layer of sand or dust in which designs, letters, or numerals might be traced and then quickly erased with a swipe of the hand or a rag" (Bloom, 2001, cited by Parikka, 2015).

Also, the *Lebombo bone*[5] and the *Ishango bone*[6] are credited as calculating or counting devices (Darling, 2004) that, combined with pebbles and shells, create tremendous mathematical and data-storing possibilities. In Zimbabwe, before European colonization, women used notches on a stick to count the days in a menstrual cycle and the months during pregnancy. At the beginning of the 21st century, the last month was still called 'the month of the staff' (Mafundikwa, 2004).

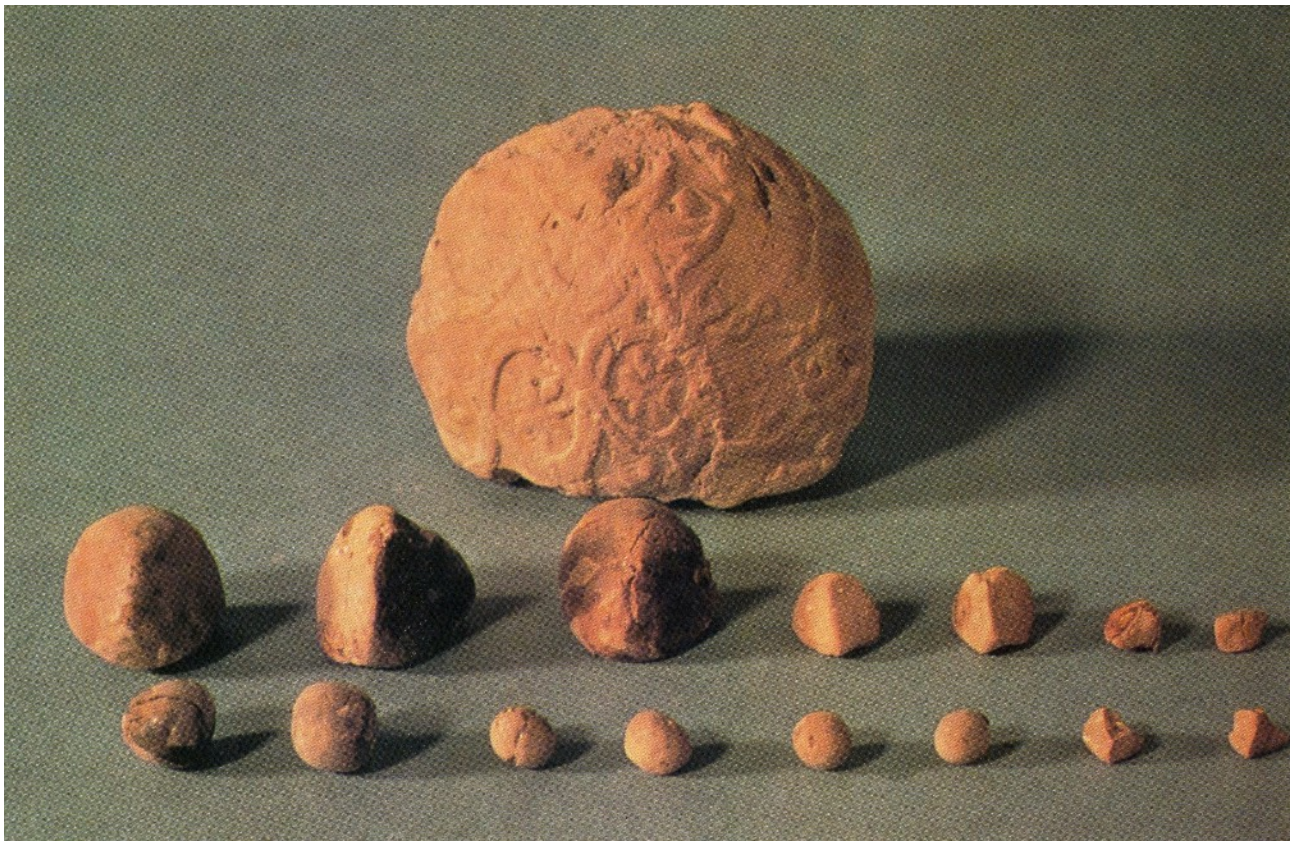
Ishango bone, ca. 20,000 BP (photo: RBINS 1950). Institute of Natural Sciences (Royal Belgian Institute of Natural Sciences)

[5] A baboon fibula from around 44,000 BP with 29 incised markings that was discovered in the Lebombo Mountains located between South Africa and Swaziland, that according to David Darling can be seen as Lunar calendar (Darling, 54 AP).

[6] A baboon fibula from around 20,000 BP with a set of mathematically sequenced incised markings that was discovered near the Semliki River in the Democratic Republic of the Congo. The amounts of incisions and the spaces in between have been interpreted both as a lunar calendar and proof of mathematical understanding of decimals and prime numbers. It includes a sharp piece of quartz affixed to one end which could be used for engravings.

Similar bones and collections of pebbles that were also engraved, some with graphic lines, some with representations of animals, are found in Israel, Lebanon, and throughout the Levant. If the bones are indeed tally sticks, "then the use of signs to communicate factual information followed the use of symbols in ritual," according to French-American archaeologist Denise Schmandt-Besserat, who contributed significantly to the understanding of tokens in the larger evolution of writing (Schmandt-Besserat, 1992; Schmandt-Besserat, 2019). These tokens were made of clay in a particular shape, like a cone or a disc, with an abstract line drawing engraved into them to represent a commodity or a specific amount. Gradually, they were also used as stamps to make imprints on the outside of a hollow clay ball, or bulla, which was closed with the tokens inside for safekeeping (to seal the deal), and later on flat clay tablets with Proto-Elamite script during the Early Bronze Age. Three-dimensional representations of commodities and numbers were being replaced by two-dimensional marks, paving the way for the subsequent revolution into proto-writing systems like Sumerian, hieroglyphic, and linear Cretan (Ifrah, 1998). The tokens also resemble the Pintadera clay stamps from the Canary Islands, dating back to the late Mesolithic, that were engraved with various graphic symbols to be used on the skin or other surfaces, including as outlines for tattoos or scarification, much like the Gran Chaco people in Paraguay and the Dayak people of Borneo did in the 20th century (Lips, 1947).

The division of scripts, understood here as distinctive writing systems of interrelated symbols that encode and transmit meaning, is not strict, as different scripts were often used simultaneously. "Systems of graphic inscription, such as ideograms or pictographs, coexist with written systems, are linked with spoken language and ideas, and function much as writing does: to record, archive and transmit knowledge and information" (Roberts et al., 2007).



Mesopotamian Bulla and clay tokens, 7400 BC (photo: Denise Schmandt-Besserat)

Clay tokens from Tello, ancient Girsu, present-day Iraq, ca. 5.250 BP (photo: Denise Schmandt-Besserat)

Even at the beginning of the 21st century, according to Afro-Cuban curator and art historian Barbaro Martinez-Ruiz, many of the same communication methods were in use among the descendants of the Kongo people near the old capital M'Banza Kongo[7], and similar positions in society as keepers of knowledge are found around the world. In addition to religious figures, there are social and political counterparts who are responsible for administering the use of graphic writing in a secular setting. One such position, which Fu-Kiau describes as a "scribe," someone whose role it is to archive information inside the traditional government (mbôngi). "This person is called Na-Makolo or Makolo and is charged with keeping for the community records of government decisions, agreements (mandaka) with other traditional governments, such as economic contracts and political alliances, and other important events. The Makolo does this by braiding a cord and tying knots onto this rope (n'sing'a makolo) or simply by cutting marks (makènko) into a piece of wood made for the purpose. The Makolo also has the related obligation of decoding the message symbolized by each mark or knot on his ropes" (Fu-Kiau, 1985, cited by Martinez-Ruiz, 2012).

Tally sticks were used to count, but also to *re-count* stories related to the past and to predict future events. Thus, they can also be called *Telly* sticks as they both help to tell or retell stories and to tell or foretell what will or might happen.

However, the cutting of marks in a piece of wood or bone and the tying and untying of knots on a rope are fleeting snapshots of an exchange of information and, due to their limited durability, do not last long over time unless they are endlessly repeated and remade. Most material culture from Neanderthals and Homo sapiens is organic and perishable and rarely makes it into the archaeological

[7] Also known as São Salvador in Portuguese, as it was called from 380 BP to 1975, currently located in the north-western Zaire Province of Angola.

record. This predicament has been described by the British archaeologist Linda Hurcombe as "the missing majority" (Hurcombe, 2014). It can also be described as the dark matter of human material history and the actions, emotions, or rituals accompanying their use as dark energy[8]. One can only surmise their existence by looking at the scarce traces they leave behind in time and space.

The use of strings, for instance, to collect and safeguard perforated mollusk shells, is deduced after use-wear analysis of *Glycymeris* shells and allows for the conclusion "that between 160,000 BP and 120,000 BP there was a shift from collecting complete valves to perforated ones, which reflects both the desire and the technological ability to suspend shell beads on strings to be displayed on the human body" (Bar-Yosef Mayer et al., 2020)

The oldest actual fibre fragment that was part of a cord was found in Abri du Maras in France and dates from the Palaeolithic Age, subsequently indicating Neanderthals' ability to manufacture cordage, and "it hints at a much larger fibre technology, [because] the production of cordage necessitates an understanding of mathematical concepts and general numeracy. Cordage production entails context-sensitive operational memory to keep track of each operation. As the structure becomes more complex (multiple cords twisted to form a rope, ropes interlaced to form knots), it demonstrates an 'infinite use of finite means' and requires a cognitive complexity similar to that required by human language" (Hardy et al., 2020). American anthropologist Bruce L. Hardy, one of the leading researchers in the study, concludes in a newspaper article: "I can't have a sentence without words, and I can't have words without the individual sounds that carry meaning. So, I can't have a rope or a cord or a bag or a net without the other steps along the way. You can't start with the end product. It's a scaffolding process that scales up" (Roberts, 2020, citing Hardy, 2020).

Next to innumerable practical uses of cordage, as traps and transportation tools to capture, contain, and carry hunted game, for instance (Lips, 1947), this evolutionary process eventually also led to complex communication and memory systems like the *Arokò*[9] symbolic message strings used by the Yoruba people of the western part of Nigeria or the *Mutanga*[10] proverb strings, used by the Lega people in the Eastern part of D.R. Congo. The making of cords and ropes, as well as the use of shells, beads, and knots, introduced binary code to include more complex and hidden messages within specific artifacts (Urton, 2003). The use of knots to mark the passing of time or *re-cord* a variety of vital information was used until the 20th century throughout the African continent and large parts of America, Polynesia, and Asia (Day, 1967; Jacobsen, 1983). For instance, the Inca people in the region of Andean South America used quipus[11] as a memory device. It is unknown, however, when or where this incredibly sophisticated information storage technology was invented, but it is mentioned in the Confucian accounts of Ancient China dating back to 2,450 BP (Lips, 1947; Jacobsen, 1983). The women of the Yakima and Klickitat people, Native American tribes based primarily in eastern

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[8] In analogy with the new model of the universe from 1990, where the amount of visible matter (the Earth, the Moon, the Sun and all the planets, stars, asteroids, comets, and gasses) is less than 5% of the universe, 68% is dark energy, and 27% is dark matter.

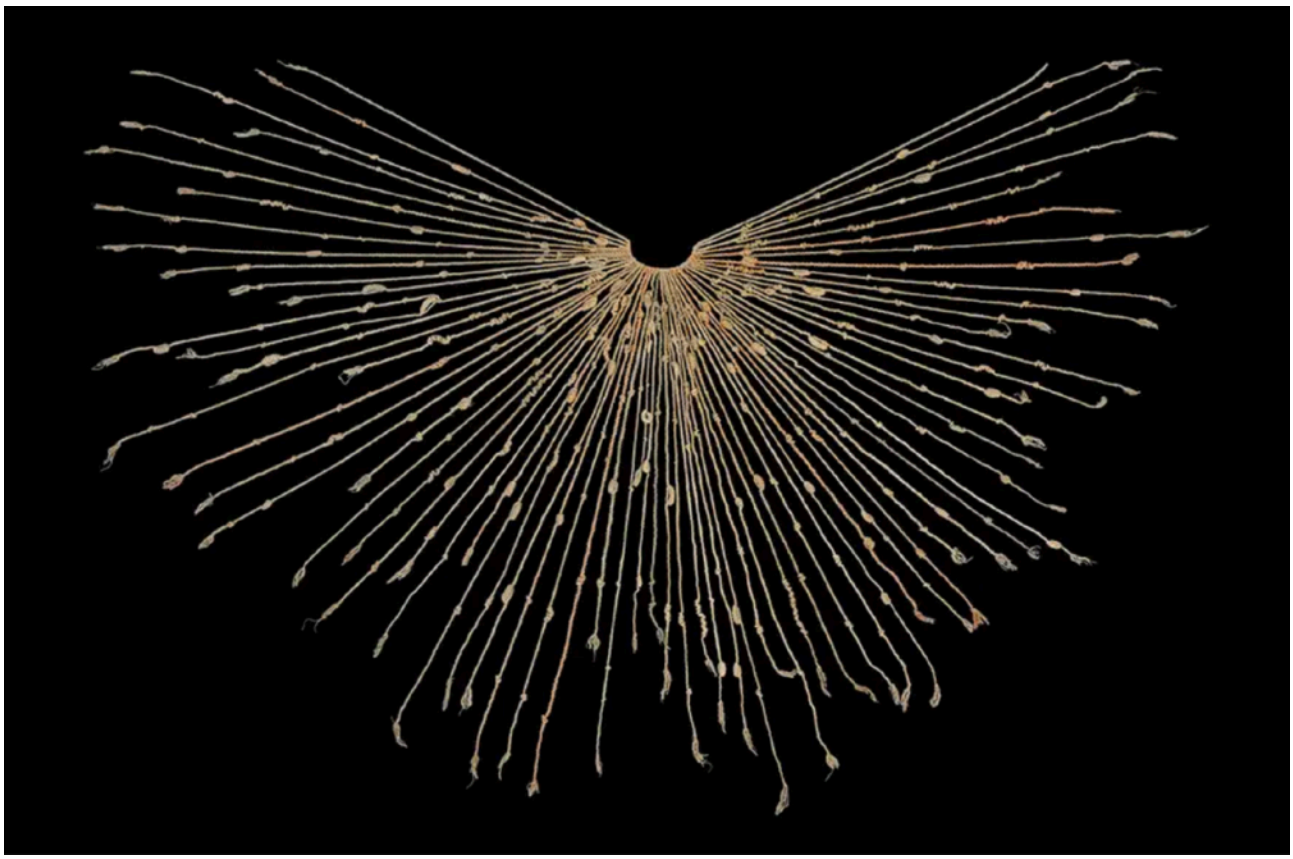
[9] Arokò is a messaging system combining different items like cowries and seeds on a string that each have their own meaning, depending on the combination and the order in which they are arranged.

[10] Mutanga are collections of tiny objects that serve as mnemonic devices that are attached to a string called Mutungu. Each object is associated with a proverb either directly by reference or indirectly by embodying an idea or symbol (Defour, 1981, cited by Ngozi za Kyongo Tchomba, 2012).

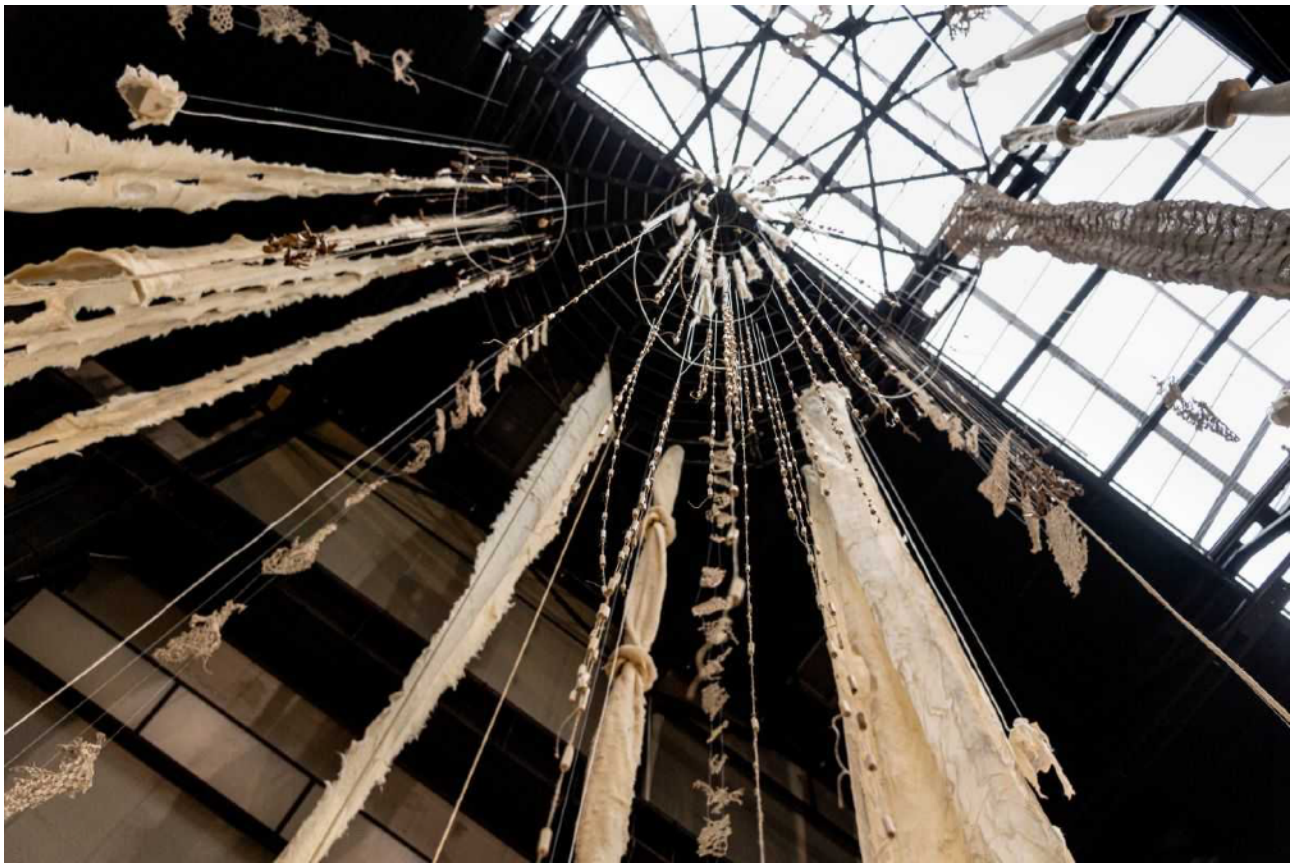
[11] Quipu are recording devices, both for mathematical calculations and for information storage, fashioned from strings that contain variable sequences of knots and obtain a different meaning by the changing use of colors, fibre, and twisting direction of the cord.

Washington state, made time balls called *Ititamat*, or *counting-the-days* balls, to register essential events during their lives. The monthly menstrual cycle was indicated by singular straightforward knots, making it easy to count backwards to find out when something happened precisely. In contrast, special events, like marriage, children, and moving house, were indicated by adding a unique pearl, a different rope, a stone, or a shell, depending on the symbolic meaning. Consequently, they could unwind their life story while recounting everything that happened from birth. The time balls were buried with the maker after death, symbolically and semantically linking to the human expression *being at the end of the rope*.

Oroko or Aroko symbolic message from Yoruba, Nigeria, collected by John Augustus Otunba-Payne in 1887.
(photo: University of Aberdeen Museums)



Cotton quipu with knotted pendant cords, Peru, +/- 500 BP © The Trustees of the British Museum



Cecilia Vicuña, *Brain Forest Quipu,* 2022, Installation View at Tate Modern © Tate Photography (photo: Sonal Bakrania)

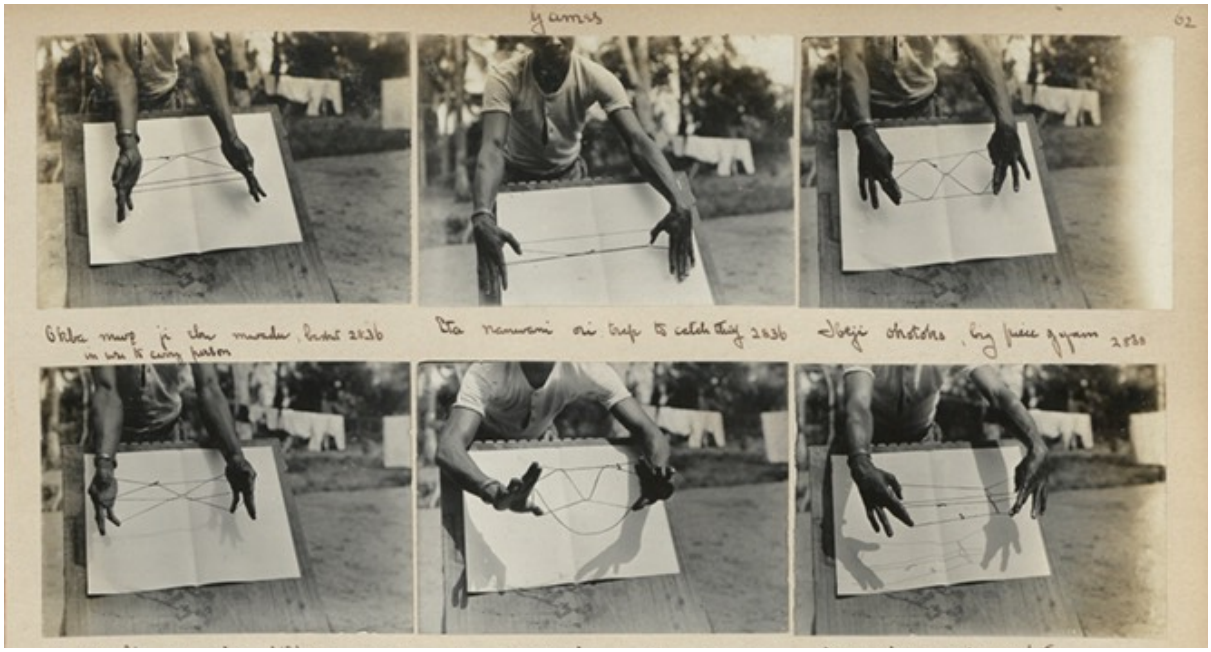
In 21st-century human culture, the use of knots as a memory device was still omnipresent, from *tying the knot* (to describe the act of getting married) to *tying a knot around your finger* or in a handkerchief (to not forget something). The semantic roots of the verb to analyze include a reference to the use of ropes as well: analysis = to untangle (from ana- *up, throughout,* and lysis *a loosening*.). Humans were known to say they lost their *string of thought* or *thread of thought* when they no longer recall where they were going while verbalizing a specific idea or story. And when they invent one all together, they *hang up* a good story.

Knots and quipus were also extensively used in 20th and 21st-century art production by the likes of Catalan artist Aurèlia Muñoz Ventura and Chilean poet, visual artist, and filmmaker Cecilia Vicuña, who created a gigantic quipu in Tate Modern's Turbine Hall in 2022 called *Brain Forest Quipu*. The work makes a beautiful analogy between the forest of memories in the brain and the mnemonic memory devices, like quipus, that branch out of the brain into the world. Vicuña made quipus for most of her art career, starting with arguably the most poetic and critical one in 1966, when she was only 18 years old, called *Quipu that Remembers Nothing*, which consisted only of an unknotted rope. The lack of knots was a critique of the erasure of quipu history and tradition due to European colonization. Still, it can also be understood as an act of refusal to create a memory (or a knot) because untangling or undoing a knot will inevitably result in forgetting.

Maarten Vanden Eynde, *Blombos Time Ball*, 2023 (photo: Maarten Vanden Eynde)

String Theory & Game Theory

Making knots is a multistep process that calls for a cognitive complexity similar to making ropes; many different hand movements are required, accompanied by a lot of practice, trial and error, to achieve the wide variety of knots that are known to humans, amounting to the thousands (Ashley, 1944). In parallel to the knapping of stones, the braiding, twining, and knotting of ropes was a form of communication, or at least served communication dexterity. They can enhance a storyline while abstracting certain vital features of the story in the shape of a string figure or *Cat's Cradle*. The position and movement of the hands that humans still use to emphasize specific keywords while speaking might be remnants of the string figure gestures used to accompany storytelling to avoid losing the narrative thread. Or, they might have served as an alternative form of communication when speech was not possible or the making of sounds too dangerous. String figures contain symbolic representations of various animals, game traps, fishing nets, weapons, tools, architectural features, boats, medical solutions, constellations of stars, weather phenomena, and mathematical abstractions. Like the ancient Morabaraba game, it was used to teach mathematics until the 21st century (Vandendriessche, 2015; Murphy, 2008).



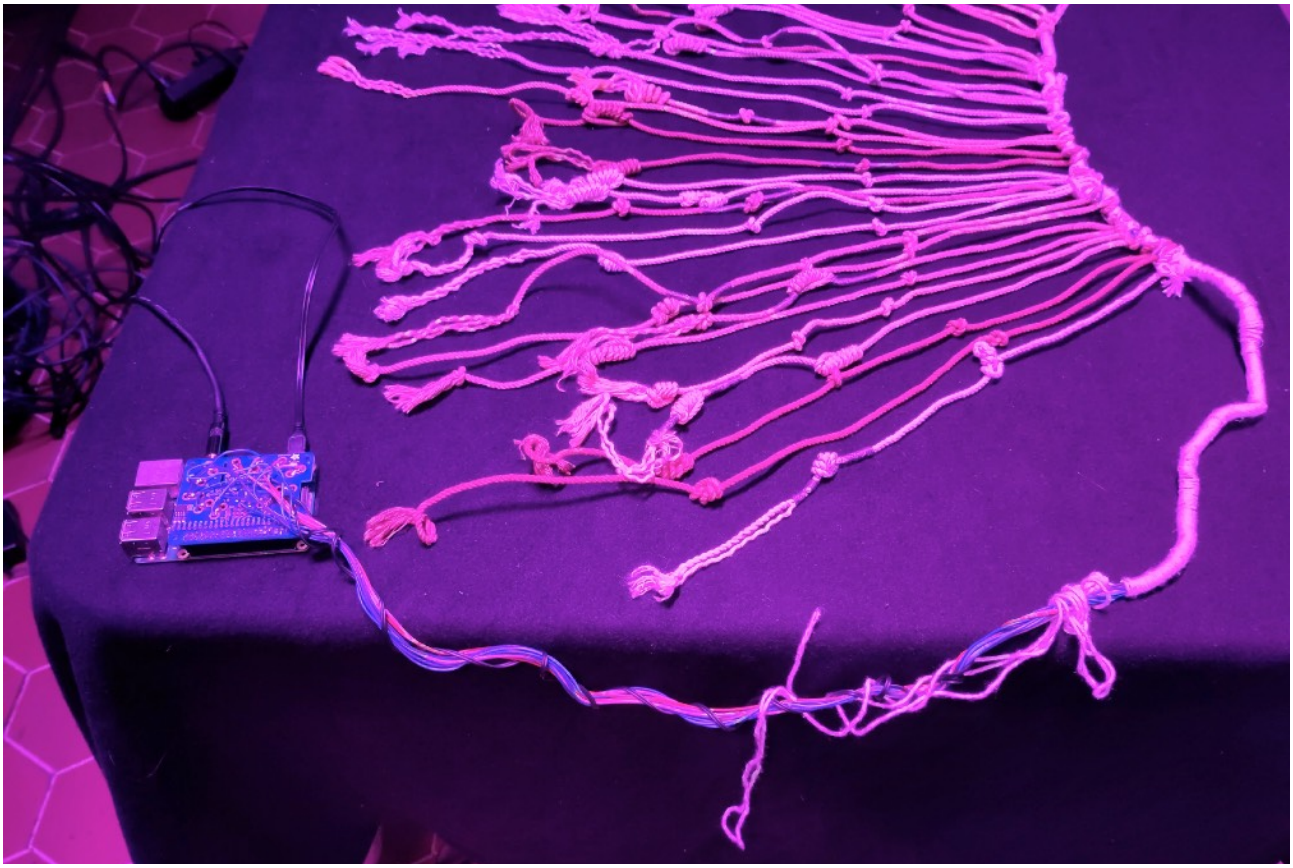
Examples of Igbo string figures or games from Nigeria (Northcote Thomas, 1911) © UK National Archives

According to Ecuadorian artist and cybernetician Oscar Santillán, sign language can also be seen as a "sensorial enactment" of quipus, or quipus as the material embodiment of sign language (Santillán & Troncone, 2020). Because of the brief longevity of ropes and cords, no archaeological remnants date back far enough to corroborate these claims of interrelation — only human imagination or AI hallucination. What does remain, however, spread around the world from the Arctic to South Africa and from Polynesia to Australia are so-called string figures or sting games, collected and published as a worldwide phenomenon for the first time by American ethnologist Caroline Augusta Furness Jayne at the turn of the 20th century (Jayne, 1906; Haddon, 1906; Cunnington, 1906; Parkinson, 1906). This highly diverse and sophisticated form of communication and storytelling was used until the beginning of the 21st century, and much like with other forms of human communication, it was updated regularly, which is visible through the added shape of the Ebusoñ, the white man's camp bed that

appeared on the African continent during European colonization. The hand gestures that string together thoughts and serve as communication tools remind us of sign language even more than quipus. However, much uncertainty about the use and functionality of the latter still exists.

The Peruvian artist Paola Torres Núñez del Prado investigated the relationship between quipus and Machine Intelligence in her multidisciplinary project *Knots of Code*. She created a computer program to facilitate the graphic visualization of quipu data. She turned a quipu into a musical instrument by weaving electrical wires into the quipu for sensorial registration, creating a truly magical experience of a tactile attempt to reanimate the so-called "Dead Media Archive" (Sterling, 1995) of the "Andean Information Age" (Santillán & Troncone, 2020).

"Writing is sound made visible and tangible, and as such it interacts intimately with our sensory systems, our ears, our eyes, hands, tongue" (Ferrara, 2022). And since writing in its broadest sense also includes the making of knots and string figures, they can be seen as collections of sensorial stories, just like Paola Torres Núñez del Prado's work or books in a library. Donna Haraway mused that "playing games of string figures is about giving and receiving patterns, dropping threads and failing but sometimes finding something that works, something consequential and maybe even beautiful, that wasn't there before, or relaying connections that matter, or telling stories in hand upon hand, digit upon digit,…". Nevertheless, string figures don't "require holding still in order to receive or pass on" (Haraway, 2016), but instead they demand a continuous movement to achieve a storyline or narrative. The story becomes *telling* through the action and repetition of the telling and retelling. "Scripts and games are always part of a dynamic group exchange of actions and reactions," according to Italian philologist Silvia Ferrara (2022). The patterns need to be actively repeated as a ritual or game to ensure the story is not disappearing or forgotten.



Live performance of Paola Torres Núñez del Prado playing music with an electronically enhanced quipu during the Artistic Research Forum in Stavanger, Norway, in 2022 (photo: Maarten Vanden Eynde)

Games fit all the requirements of a perfect memory device, including repetition and ritual, transition towards completion, and adaptability depending on specifics of time and place, as well as players. Because of the striking resemblance between old petroglyphs, string games, and outlines of board games, could it be that they were initially used to transmit information, i.e., to learn something? And that by the constant *re-playing* (to both play and listen again) or *re-counting* (to both tell and count again), a continuous repetition ritual was instigated and stimulated, or learning by playing? That is probably why they have been around for so long and, in some cases, still exist today, like the *Morabaraba* game, also known as *Merels* board games or *Nine/Twelve Men's Morris*, the *Game of the Goose*, or *Cat's Cradle*.

Several thousands of examples of similar game boards, with some variations, have been found around the world, including in Valcamonica[12] in Italy and Fontainebleau[13] in France, dating the game to at least the Mesolithic era. The combination of several declining squares, with horizontal, vertical, and sometimes diagonal cross-sections, allows for a multitude of mathematical calculations, making it a remarkably successful tool in mathematics education. But the game does more than that. South African mathematicians and educators Mogege David Mosimege and Nkopodi Nkopodi analyzed the effects of playing the game in an educational context and put forward that next to the experience "to learn the language and vocabulary of mathematics, develop mathematical skills, develop ability with mental mathematics" it is also a tool to help "devise problem-solving strategies [and that it] also leads to discovery of patterns, decision making, and logical reasoning" (Mosimege & Nkopodi, 2009).

The fact that most *Morabaraba*-like patterns from the Mesolithic era are not on a flat, horizontal surface and would therefore not allow for the game to be played on site as the pebbles would fall off the board, which was the conclusion after analyzing the largest survey of similar geometric grids around the world by the French archaeologist Christian Wagneur and other affiliated researchers of GERSAR[14], dismisses the more logical explanation that the geometric petroglyphs themselves were not necessarily overlapping with the physical place where the game was played. They might as well have an archival function, kept secret and hidden in a safe space, but accessible to use or educate others when need be, like a blueprint or a hard copy. Portable memory devices like rocks, bones, shells, and sticks with signs and patterns engraved or drawn on them should be interpreted similarly as manuals for future use instead of the actual functional pattern itself.

Morabaraba means *to mill* or *to go round in a circle* in Sotho[15], which is similar to the game of *Mehen*, meaning *the coiled one*, which looks like a snake and guides the player step by step towards the end of the game. It resembles the mysterious *Phaistos disc*[16], which, although impossible to read, can be understood as part of a knowledge system for storing and communicating information, much

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[12] The rock drawings in Valcamonica (Camonica Valley), with a staggering number of catalogued incisions, between 200,000 and 300,000, are located in the Province of Brescia, Italy, and constitute the largest collections of prehistoric petroglyphs in the world.

[13] In Fontainebleau more than 2000 different sites have been discovered so far, dating from the Mesolithic to the late Paleolithic era (between 10,000 and 20,000 BP) in an area of more than 1000 m^2.

[14] *Group d'Etude, de Recherche et de Sauvegarde de l'Art Rupestre* (Group of Studies, Researches and Protection of Rock-Art GERSAR). Founded in 1975 in France, the main purpose of the association is to study and make better known French rock art in general and more particularly rock art from Île-de-France, including Fontainebleau.

[15] Sotho or Sesotho is a Southern Bantu language spoken primarily in Lesotho, South Africa and in Zimbabwe.

[16] The Phaistos Disc is made of fired clay and contains 241 tokens, comprising 45 distinct signs. It was found on the island of Crete and dates from the middle or late Minoan Bronze Age (between 5000 and 3000 BP), although even this is debated. Its use, meaning, and origin is one of the great unresolved mysteries in archaeological history.

Mehen game, Early Dynastic Egypt © The Trustees of the British Museum

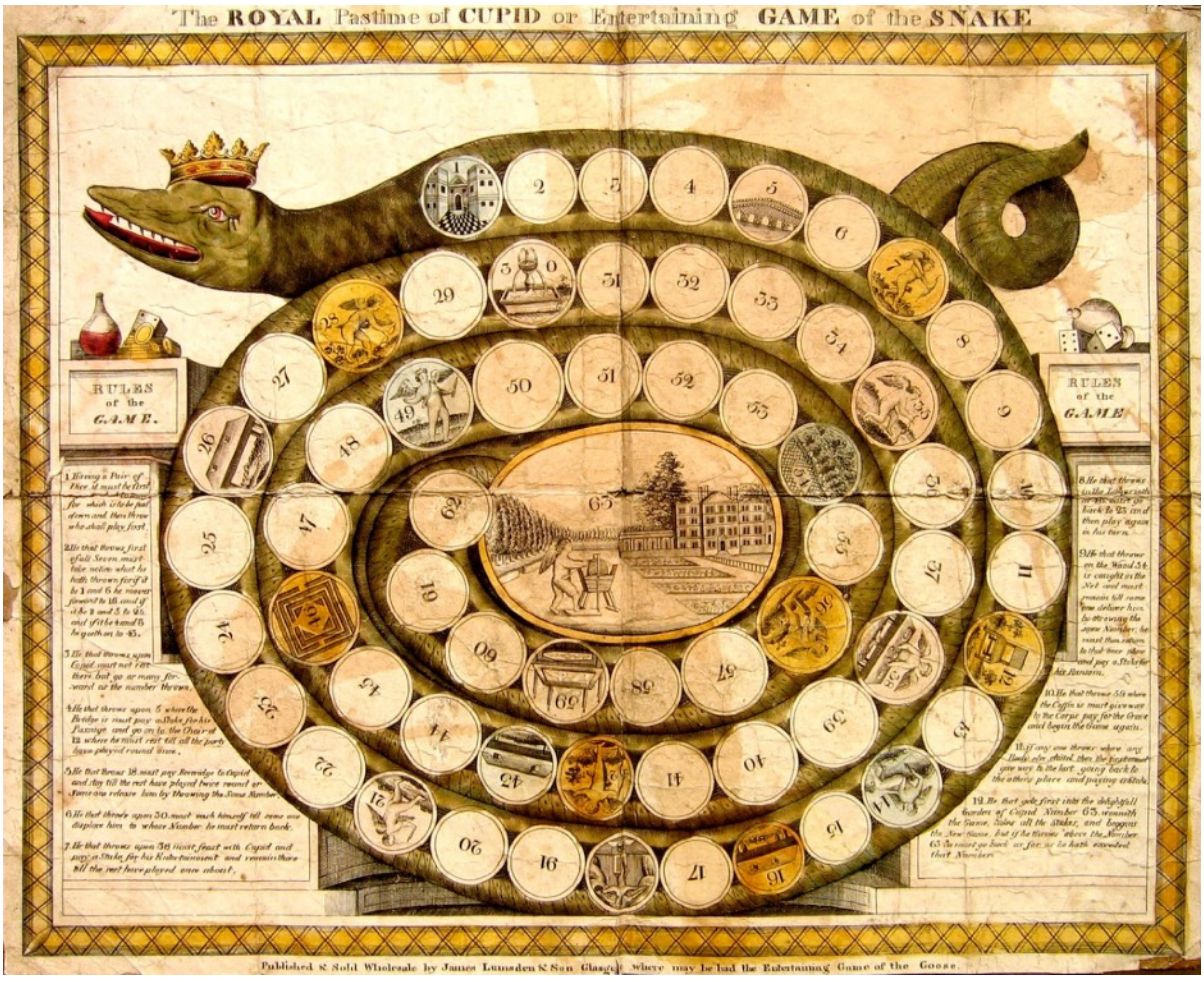
Owela game, Namibia (photo: Nela Shikemeni)

like a computer or any other memory device. A similar game, known as *The Game of the Goose*, still exists today, which looks a lot like *Snakes and Ladders* or *The Game of Wisdom*. Originally from India, the game was used to teach children about Hindu traditions and religion. *The Mansion of Happiness* that arrived from it and became a hit in England and America had a similar outline: to learn moral lessons rewarding piety and honesty while punishing immodesty and cruelty. Even if other and older discs that look like a *Mehen* game are found, the *Phaistos disc* is the only one that includes signs and thus might explain what is happening along the way or what one needs to do or remember while following all the squares toward the head or the tail of the snake.

There are countless examples of so-called Roman or Egyptian games, like Senet (meaning passing), Mancala (meaning to move), Hounds and Jackals (also known as 58 holes), as well as Tab, Seega, Aseb, and Latrunculi, that all use the combination of geometric grids made with lines or holes and pebbles to move around to achieve something or arrive somewhere. All of them are present throughout the sub-Saharan African continent, both in the form of petroglyphs and as contemporary games like Wari (Oh-Wah-Ree), Omweso, Bao, Gabatta, Ayo, and Kisolo (Eglash, 1999). It is thus safe to assume (or remember anew) that they existed before the emergence of the Egyptian civilization and played an indispensable role in developing human culture and consciousness.

Phaistos Disc, Crete, between 5000 and 3000 BP. © Heraklion Archaeological Museum (CC BY-SA 4.0).

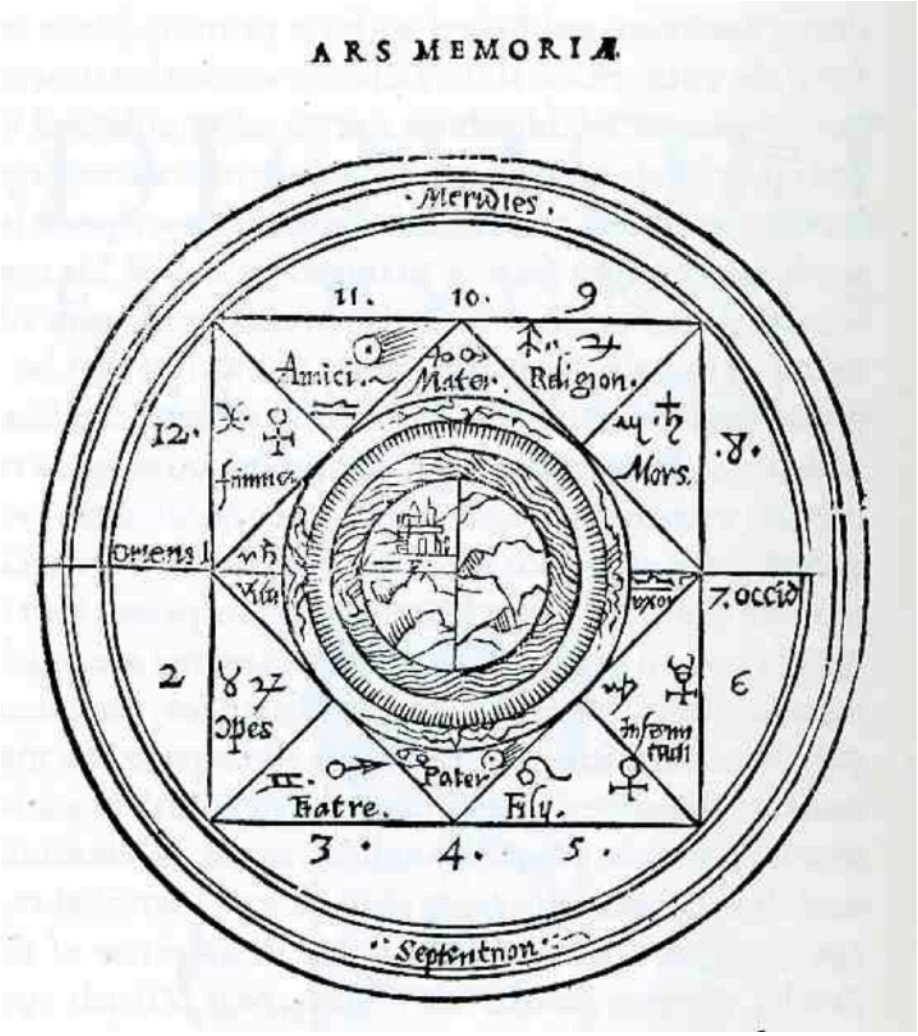
Game of the Goose, 1960s (photo: Luigi Ciompi & Adrian Seville)



The Royal Pastime of Cupid, or *Entertaining Game of the Snake*, 1820s (photo: Adrian Seville)

Damnatio Memoriae

The centuries-long effort to separate ancient animistic belief systems from Western and Euro-centric ones caused a serious disconnect and rupture in understanding human history and evolution. Starting in ancient Greece, a purposeful extinction attempt of pagan knowledge and wisdom was set in motion. It also marked the end of the so-called *Ars Notoria*, the magical art of memory. Attributed to Apollonius or Solomon, but with clear connections all the way back to the beginning of graphic writing systems, *Ars Notoria* combined figures and diagrams with shorthand *notae* (the Latin word for marks) already in 2900 BP. A few hundred years later, Marcus Tullius Tiro, known as the *father of stenography*, introduced the Tironian notes (*notae Tironianae*) as an elaborate shorthand technology that contained more than 4,000 characters. He was an enslaved servant and private secretary of Cicero, arguably the *father of the Roman Empire* and writer of more than three-quarters of all surviving Latin literature. By the time of the Carolingian dynasty, between 1,200 and 1,300 BP, the *notae* vocabulary reached 14,000 characters. Still, it quickly disappeared after that as it became associated with magic and witchcraft and was severely suppressed and condemned. It only resurfaced after 800 BP through the recurring efforts of Thomas Becket, archbishop of Canterbury, who rekindled interest, but it was never able to gain similar momentum as it had before. Thomas Becket was murdered in Canterbury Cathedral in 780 BP, and only a few *notae* survive, like *et* (⁊ meaning *and*) in Ireland and Scotland (Yates, 1966).



Giordano Bruno, *Ars Memoriae,* 1582 (photo: John F. Ptak)

The fear of shorthand *notae* and its potential dangers, as only the ones who speak it know what is being said, continued to influence human behavior towards uncontrolled language developments all the way to the early days of Artificial Intelligence. In 2017, Bob and Alice, two artificially intelligent chatbots of *Facebook*[17], were shut down when they invented their own language to negotiate trade deals involving hats, balls, and books with a specific value. When Bob said: "I can i i everything else . . . . . ." Alice responded: "balls have zero to me to me to me to me to me to me to me to…" Developing a new and more efficient way to communicate became a standard procedure for AI technology[18], creating a striking parallel between how humans and AI constantly develop new languages to improve communication (Gawdat, 2021).

All words or *notea*, however, eventually disappear or have a *half-life*, according to British author David Farrier, who made the marked analogy with decaying radioactive radiation. Typically, between 750 and, in extreme cases, 10,000 years, "use wears down the value of some words, and modifies others, but like radioactive elements, all are subject to the same inexorable decay." That is why human words are no good markers for communicating the dangers of radioactive waste in deep time. Thomas Sebeok, an American semiotician and founder of a new branch of knowledge, *nuclear semiotics*, therefore proposed in 1984 to form an atomic priesthood that would organize specially designed annual rituals about the dangers of nuclear waste because recurring rituals outlive all other symbolic communication techniques and technologies (Farrier, 2020; Vanden Eynde & Carpenter, 2022). Or as Alice, the AI chatbot, could have said: "Physical nuclear waste markers 'have zero to me to me to me to me to me to me to me to me to'…"

Around 1570, all the valuable knowledge of symbols, diagrams, and other memory techniques was collected, popularized, and distributed by the Italian philosopher, mathematician, cosmological theorist, and Hermetic occultist Giordano Bruno in his epic publication *De Umbris Idearum: On the Shadows of Ideas* (Bruno, 1582). He had to flee several times from the Roman Inquisition, first to Geneva and then via France to England, during which he was protected by the French royal family and King Henry III himself because of his extraordinary memory skills and knowledge. Eventually, he was caught by the Inquisition, convicted of heresy, and burned on the stake upside down in 1600. Since then, most of this historical knowledge related to memory and remembering was seen in Western Europe as occult, superstition, and part of black magic.

A new wave of erasure and forceful forgetting took place around the world during European colonization, starting in the 15th century. Together with the violent spreading of Catholicism, vast amounts of valuable indigenous knowledge were destroyed. Human history was rigorously rewritten, placing Western culture and science at the heart of human evolution. Choreographer Thomas Talawa Prestø, founder of Tabanka Dance Ensemble, called it *Epistemicide*, the destruction of existing knowledge by implementing the force of erasure, or *damnatio memoriae*.

Fictional concepts like *prehistory* or *pre-literary history* were introduced during the European Age of Enlightenment (the first use of the word prehistory in English occurred in the *Foreign Quarterly Review* in 1836). It was initially brought forward by antiquarians who used the word *primitive* to describe societies before *written* records. The subsequent invention of the geological time scale for pre-human periods by Scottish geologist James Hutton and the introduction by Danish archaeologist

[17] Facebook is a social media and social networking service that was very popular in the beginning of the 21st century.

[18] By the beginning of the 21st century there was already more machine-to-machine communication occurring over the internet than human communication (OECD, 2012).

Christian Jürgensen Thomsen of the three-age system for human prehistory (Stone Age, Bronze Age, Iron Age) kickstarted the further semiotic and linguistic specialization and separation of interconnected technological inventions and anthropological evolutions, resulting in a fragmented and biased understanding of human culture. This artificial and fallacious view of human history and evolution through a Western scientific telescope had a lasting effect on the apprehension of the interwoven properties of deep history. Breaking the mirror in which humans only see themselves was instrumental in creating a kaleidoscopic worldview that reflects the world's inherently multilayered and multifaceted representation.

According to the Canadian archaeologist, anthropologist, and ethnohistorian Bruce Trigger, the emphasis on progress reflected a European perspective on history and humanity that dominated but did not survive the nineteenth century (Trigger, 1989, cited by Hoffecker, 2011). But it was only after the turn of the 20th century that the necessary rewriting of human history began to have considerable influence, and slowly but surely, the air was let out of the self-inflated Eurocentric air castle. “The viability of the traditional narratives of patriarchy, imperialism, and colonialism were vigorously challenged and disproved by the sort of reassessment of history called for and developed by marginalized groups and societies. This sort of undermining of the truth and authority of history is exemplified by Edward Said’s landmark book *Orientalism*, which issued a clear challenge to the ways in which colonial history was constructed and biased” (Gibbons, 2007). As a result of the relentless work by countless scholars like Senegalese historian and anthropologist Cheikh Anta Diop, American philosopher Molefi Kete Asante, and Congolese linguist and historian Théophile Obenga, other humans were made to understand as well how graphic writing systems and mathematical tools and knowledge led to the magnificent wonders of the Egyptian civilization, which in its turn instigated the further evolution of alphabetic writing and countless other technological and scientific developments throughout the rest of the world (Diop, 1955; Diop, 1959; Diop, 1967; Diop, 1973; Asante, 1987; Asante, 2000; Obenga, 1973; Obenga, 1992). The American linguist Konrad Tuchscherer summed it up nicely a few decades later when he said: “The Egyptian system drew from many highly codified African graphic systems [including rock art, knotted cords, tallies, geometric pottery motifs, weaving designs, and scarification] which, even if not phonetic, were highly systematized and recorded as well as communicated information” (Tuchscherer, 2007). This led the American linguist Christopher Ehret to conclude, with some acquired institutionalized surprise, that “over the long run of north-eastern African history, what emerges most strongly is the extent to which ancient Egypt’s culture grew from sub-Saharan roots” (Ehret, 2002).

This epic human evolution from counting to graphic writing systems originating in Africa resulted in *Unicode*, first proposed in 1987. The *Unicode* information technology standard for consistently encoding, representing, and handling text comprised most of humanity's writing systems and was regularly updated. It was even open to suggestions. However, when Dutch artist Alexandra Crouwers proposed a stone tool emoji and a hand stencil emoji in 2020, they were both refused for lack of expected user frequency.

By the end of 2023, *Unicode* defined 149,813 characters, covering 154 modern and historic scripts, symbols, non-visual control and formatting codes, ideographs, hieroglyphs, sign language, emojis, and emoticons. It was a utopian attempt to preserve, at least digitally, and make available what has not yet disappeared in the dark matter of the past. But humans tend to forget, regardless of the many variations they have at their disposal, to say that they won’t.

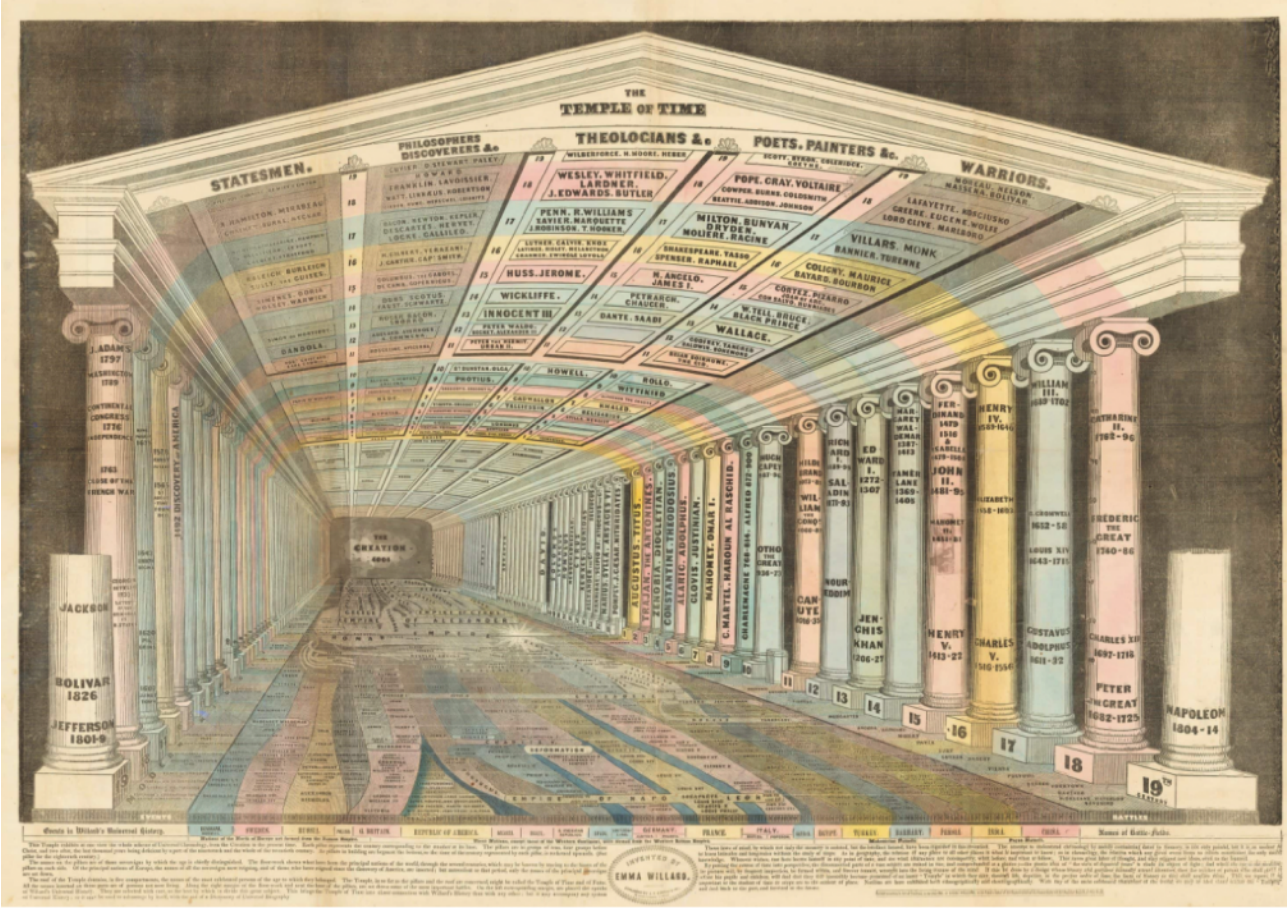
Stone tool and hand stencil emoji by Alexandra Crouwers, 2020

For example, the entire Western memory tradition is based on an unknown rhetoric teacher. Oh, irony, the art of memory springs from a book by a forgotten author... (brilliantly put forward by the English historian Frances Yates in her seminal book *The Art of Memory*, referring to *Rhetorica ad Herennium*). The book without a known author contains the first confirmed description of a mnemonic technique and provides the first complete methodological treatment of the memorization of speeches.

Using images of places, or entire palaces, to store memories and allow easy access by walking through a landscape or navigating from room to room in a virtual building became known as *the method of loci* (the Latin word for *place*). It is still the preferred method for most human memory champions to retain as much data as possible. There is a difference, however, between images that function as earmarks of memories inspired by empirical experiences or events and images that are imagined to remember something. The first is called natural memory, whereas the latter is called artificial or mnemonic memory.

British art critic and curator Joan Gibbons concluded that "the development of artificial memory was highly dependent on techniques of visualization, such as the location of a piece of knowledge in an imagined, clearly defined locus (often a building) or the attachment of data or ideas to striking (and therefore more memorable) images. Because of this emphasis on imaging or the formation of impressions, memory became closely related to imagination", echoing Aristotle. As a result, "the way that memory is valued, then, has shifted enormously from the idea of it being a storehouse of data which, given the right techniques, is recoverable in an ordered manner to the notion that it is a key to our emotional understanding of ourselves and the world" (Gibbons, 2007). Humans are known to ask: *do you feel me?* when they want to make sure that they are being understood well.

The Greek philosopher Socrates assumed there is “a block of wax in our souls” on which impressions can be left behind (Yates, 1966). These impressions, however, like experiences influencing the block of *DNA wax*, change over time. Whenever a memory is recalled, the old image is written over by the new one, analogous to how photographs replace the memories of the photographed experience. It becomes a 2.0 version of the original memory (Genova, 2021). That is why the Greek polymath Aristotle concludes in *De Memoria Et Riminiscentia* that “memory belongs to the same part of the soul as the imagination; it is a collection of mental pictures from sense impressions but with a time element added, for the mental images of memory are not from perception of things present but of things past” (Aristotle, 1473, cited by Yates, 1966, and Gibbons, 2007). Humans constantly create and recreate images of past experiences that become new and renewed experiences whenever they remember them. This is called the phenomenon of *intrinsic forgetting* (Scharf, 2022) and proves that forgetting (or disremembering) is an inseparable part of human remembering (Genova, 2021); they can’t do one without the other and seem doomed to undergo them simultaneously all the time. But not all information is lost. Some experiences are so deeply engraved in human DNA that they even survive over multiple generations. *Anamnesis*, in Plato's theory of epistemology, refers to the recollection of innate knowledge acquired before birth. The concept posits the claim that learning involves rediscovering knowledge from within oneself or humanity’s mind at large.



Emma Willard, *The Temple of Time,* 1846 (Wikimedia Commons © public domain)

Eat, Sleep, Rave, Repeat - Eat, Sleep, Rave, Repeat[19]

The only way to avoid oblivion and disappearance into the dark-matter side of history is endless repetition, recreation, and retelling. The German psychologist and pioneer in the experimental study of memory, Hermann Ebbinghaus, introduced in 1885 the notion of "the forgetting curve." It explains one of the most common memory failures: transience, which is the process of forgetting that occurs with the passage of time. The stronger the memory, induced on purpose or accidentally by a memorable experience, the longer someone can recall it. Afterwards, unless memory is kept alive through repetition, reviewing, or reciting, for instance, a typical "forgetting curve" graph shows that humans tend to halve their memory of newly learned knowledge in a matter of days, and 90% of all new information within a week (Ebbinghaus, 1913; Genova, 2021).

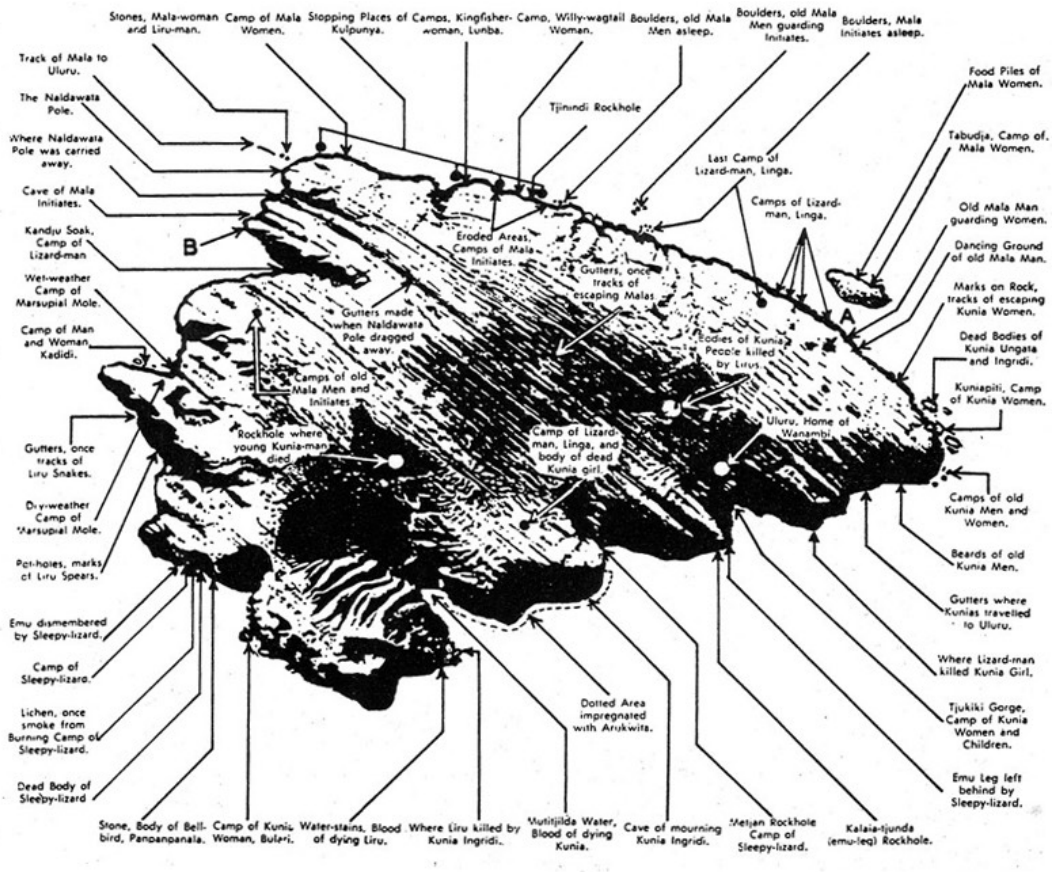
Endless recreation and reproduction are also how humans store information biologically. The genetic code, the DNA (deoxyribonucleic acid), is a very stable molecule that has endured over millennia and functions as a template for mRNA (messenger ribonucleic acid). The coding sequence of the mRNA determines the amino acid sequence responsible for producing proteins (Cooper & Hausman, 2004). These proteins determine human actions and behaviors. Changes in the protein output of mRNA are caused by physical and emotional experiences that humans undergo that are turned into memories. Contrary to the longevity of the DNA template, the oldest sample so far found in Greenland being 2 million years old (Kjær et al., 2022), mRNA only lasts for hours, and the protein that is produced while transcribing the information from the DNA template, only lasts for days. The only way to store a memory or preserve information from an experience is by continuously reproducing the same or similar proteins. Canadian-Guyanese neuroscientist André Fenton compares it with the *Ship of Theseus paradox,* in which the question is raised whether a ship that gradually replaces all its parts is still the same in the end (Vanden Eynde & Fenton, 2023). Whether it is the same ship or not, this is how humans preserve memories, as recorded experiences, by repetitive and continuous reproduction of mRNA, over and over again, day in and day out.

Since societies don't remember things by themselves, humans invented systems and technologies to transmit knowledge. Ritual is one of them, and similarly to the functionality of mRNA, it works using repetition, ensuring that the ritual is itself remembered. "Rituals are prescribed and are therefore a deliberately learned discipline. They can vary in intensity and degree, be more or less called out as a memory, and the feelings and emotions can be induced by pain, anticipation, relief, release, or pleasure. But whatever the variation, ritual performance is a corporeal experience, not just an image. Ritual creates a memory, which is reinforced when repeated" (Feuchtwang, 2010). That is why rhythmic music, games, chanting, and song lines are good educational tools and excellent memory aids. They reinforce and reaffirm physical and emotional memory, relating both to souvenirs from an exhilarating experience and to lived or inherited trauma.

The largest and longest-lasting memory device is the massive natural Central Australian monolith, *Uluru*. The pathway encircling *Uluru* is nearly nine kilometers long and forms one continuous score or mnemonic memory that utilizes almost every feature on the rock's surface.
Australian anthropologist Charles Mountford tried to map the entire pathway of what was then still called the *Ayers Rock*. "The Anangu traditional owners describe *Uluru* as part of their knowledge system, Tjukurpa, which they explain has many deep, complex meanings, including the law for

[19] Lyrics from a song by Fatboy Slim and Riva Starr (2015)

caring for each other and their Country, the relationships between people, plants, animals, and the physical features of the land, the past, the present and the future. It is not necessary for the Anangu knowledge specialists to be walking the rock to recall the stories. The sequence of sites is so well-known after years of learning that they can travel and part of the perimeter in their memories whenever they want. This is the art of memory exactly as described by the ancient Greeks" (Kelly, 2016). Not only was *Uluru* used as a gigantic songline, but the entire Australian continent was mapped as a memory palace by walking through the landscape. The famous Russian mnemonist Solomon Veniaminovich Shereshevsky, better known as 'S,' applied the same technique starting in the 1920s to remember impossible amounts of information or words in languages he did not speak. He had an extreme form of synesthesia, where all his senses were activated when only one was targeted. When he heard a word, he saw, smelled, and tasted images instantly, and when he did not know the word, they became lines, dots, and splashes, accompanied by sounds and other sensations. To remember the correct sequence, he distributed them along some imagined roadway or street, through which he could later take a mental walk and remember every image, word, or number, even years later (Luria, 1989). Remembering by instrumentalizing repetition is called *rote learning,* with the premise that the recall of repeated information becomes faster the more it is repeated. Etymologically, the origin of learning by *rote* is unknown, but it is no coincidence that learning by *route*, i.e., learning by walking, sounds familiar. British artist Richard Long visualized this accurately in many early career works, like the iconic *A Line Made by Walking* of 1967. In the human brain, the hippocampus is not only tied to memory but also the capacity to move through space. It houses the human spatial positioning system, or internal GPS, which helps navigate space and data (Ferrara, 2022). Along the same line, humans used their bodies to measure space and calculate distances in nearly all human cultures, like thumb, foot, leg, pace, and fathom (Kaaronen, Manninen, Eronen, et al., 2023).



Map of *Uluru* song lines by Charles Mountford (photo: Kelly Lynne)

Songs and visual images are stored in the prefrontal cortex and, as a result, are often the last stronghold of memory for people suffering from Alzheimer's. Putting on music or specific sounds can trigger a temporary revival of Alzheimer's patients who seem to be back *in the moment,* recollecting the entire score or emotional sensation. The prefrontal cortex also mediates humans' ability to plan, conceptualize, symbolize, make rules, and impose meaning on things. It controls physical drives and turns basic feelings into complex emotions. It is the first point of entry to make sense of patterns that are omnipresent, including recurring faces, correlating rhythms, sounds, and smells, giving humans their distinct *patterning instinct* to make sense of the world (Lent, 2017).

Creating song lines and repeating scratched geometric patterns on rocks and inside caves are two distinct ways to merge memory and landscape, or the lyrical and the literal. "Histories are written into landscapes through ritual and myth, but history, as written from archaeological and documentary evidence, functions in a quite different mode from mythical temporality, just as the landscape of events and histories of them are quite different in mode from a ritual landscape, which is cosmological or cosmogonic, that is, of a world and its origins and of humanity in it" (Feuchtwang, 2010). To understand and *think-with* the mythical and societal temporality of such ancient memory devices, humans need to implement a 'fundamentally pluridisciplinary global and comparative archaeology,' as Cameroonian archaeologist Augustin F. C. Holl called for (Capo Chichi, 2018), or, coming from a very different queer-historical perspective, humans need to commit to *polydisciplinamory* (Loveless, 2019). This neologism was introduced by Canadian artist and author Natalie Loveless to add to polyamory's critique on mononormativity within disciplinary specialization.

According to Australian archaeologist V. Gordon Childe, the material objects of archaeological record must be treated 'as concrete expressions and embodiments of human thoughts and ideas' (Childe, 1956, cited by Hoffecker, 2011), evoking their emergent *thing-power* (Bennett, 2010), something Leroi-Gourhan has stressed over and over as well. Sadly, in the middle of the 20th century, the cultural and social sciences were underdeveloped in Europe, according to the American anthropologist John M. Janzen, or, instead, they were developed in a direction opposite to that which would have allowed them to see the meaning of a cosmogeny as a set of cultural axioms (Janzen, 1969). Instead, Western cultural dogmas dominated the world stage during the last centuries of the second millennium and suppressed any alternative interpretation of cosmological coalescence or Harawayan *sympoiesis (becoming-with)*. And when humans repeat one specific axiom repeatedly, like the brain being the storehouse of memories or the origin of science and civilization within a Western cultural context, their hallucinations become their reality. They even say that when you believe it hard enough, it becomes true (although deep in their *heart* or block of wax, they know it isn't true). For most of the past, humans have viewed the heart, not the brain, as the fundamental organ of thought and feeling (Cobb, 2020), and most human societies at some point in their history lived by a more holistic, heart-centered worldview. Still, only when moving into the third millennium were human scholars able to reconnect with the ancient 'archaeology of the heart' (Supernant, Baxter, Lyons, Atalay, 2020) and write a more humane, although not necessarily anthropocentric, and inclusive history of humankind (Schmidt & Patterson, 1995; Smith, 2012). They just need to keep repeating it to make sure it isn't erased again.

Homo Technicus

Inventing external memory devices changed humanity forever and installed an unprecedented interdependency that is still in place today. The French philosopher Bernard Stiegler (1998) called it "originary technicity," insisting on the common origin of humans in technology and technology in humans, and even went so far as to define modern humans as prosthetic beings. Andy Clark took it even a step further and claimed that ontologically speaking (modern) humans are a "cyborg species" (Clark, 2003), something Donna Haraway also proposed in the 1980s, although coming from the *brain-plasticity* angle when she talked about "cyborgian assemblages of organic and non-organic matter (and meaning) that can change" (Haraway, 1988, cited by Pitts-Taylor, 2016). Hominins became so dependent on the technologies they invented, starting with the first "Lomekwian" stone tools (Harmand et al., 2015), that they could not live anymore without them. In a sense, they are only alive *because* of them. Mentally it might have prepared *Homo sapiens* for the consanguinity contemporary humans are currently still experiencing with technological devices, making it hard to say where humans, as naked apes, end and where technology, as in everything that is man-made, begins.

American architect, systems theorist, and futurist Richard Buckminster Fuller argued that on top of the human body and brain being inseparable from prosthetic technological extensions, the human body was itself the first tool. This technology can and should be modified (Fuller, 1938, cited by Colomina & Wigley, 2016), blowing the door wide open towards 20th-century *transhumanism*[20]. Once the potential was demonstrated of slow and step-by-step development of "technology from the bodies and materials up" (Tomlinson, 2018) to generate complex behavior, it turned the Artificial Intelligence study on its head in the 1990s. It also expanded the understanding of *transhumanism* towards a more protracted coalescence process that started millions of years ago. It took a while before hominids realized the power of repetition, but once they did, they kept on going, and going, and going. This sobering realization of underestimated prehuman hominin intelligence changed autonomous robotics forever and had an inordinate influence on the making and programming of humanoid robots. The subsequent explosion of smarter, faster, and smaller memory devices created a new stratigraphic layer on planet Earth that would co-define the Anthropocene.

In the 1920s, Russian geologist Vladimir Vernadsky, in conversation with the French paleontologist Pierre Teilhard de Chardin and mathematician Édouard Le Roy, came up with the term *Noösphere,* or the "sphere of the mind," compiling everything that the mind was able to produce. Later, in 1945, Vernadsky described it more as a geological phenomenon where humans were, for the first time, becoming a *large-scale geological force*. American geologist, paleontologist, and stratigrapher Peter Haff, who coined the term *technosphere*, goes as far as to call "technology the next biology" (Haff, 2013), building further on the notion that "computers are no longer merely our tools. They are a species in their own right, neither independent from us nor subservient to us" (Pask & Curran, 1982). In 2019, the Syrian-Australian computer scientist and interdisciplinary artist Iyad Rahwan and his colleagues at the Max Planck Center for Humans & Machines, where he was Director, proposed treating "machines and algorithms as if they were organisms roaming a new ecosystem" (Scharf, 2022). They were, however, all building further on British author Samuel Butler's dystopian *Darwin Among the Machines,* published in New Zealand in the daily newspaper *The Press* under the

[20] In 1951, British evolutionary biologist and eugenicist Julian Sorell Huxley coined the term *transhumanism*, which he described as 'the idea of humanity attempting to overcome its limitations and to arrive at fuller fruition.'

pseudonym *Cellarius in* 1863. "… the machines are gaining ground upon us; day by day we are becoming more subservient to them; more men are daily bound down as slaves to tend them, more men are daily devoting the energies of their whole lives to the development of mechanical life. The upshot is simply a question of time, but that the time will come when the machines will hold the real supremacy over the world and its inhabitants is what no person of a truly philosophic mind can for a moment question" (Butler, 1863).

The world became rapidly inhabited by more and more "technospecies" that formed "technofossils" in the stratigraphic layers of the future (Zalasiewicz, 2014; Zalasiewicz, 2020). Quickly, there were more active cell phones than humans, for instance, and their extensive use made cell phones, particularly *smart*phones, become part of the human sense of self, resulting in *nomophobia* (no-mobile-phone phobia) when they were separated from them. At an accelerating pace, the human brain no longer saved the information the *smart*phone was expected to store and provide (Colombian & Wigley, 2016). Memories were offloaded on *the cloud* instead of the previous *mind of many*, consisting predominantly of other humans and analog devices, making them increasingly dependent on *smart*phones that use the Internet to access externally stored information. The ability to ask questions on or from the phone gave the sense that the Internet was part of humanity's cognitive toolset. (Wegner & Ward, 2013).

Maarten Vanden Eynde, *Technofossil [Samsung E570]* (2015), Katanga, D.R. Congo (photo: Maarten Vanden Eynde)

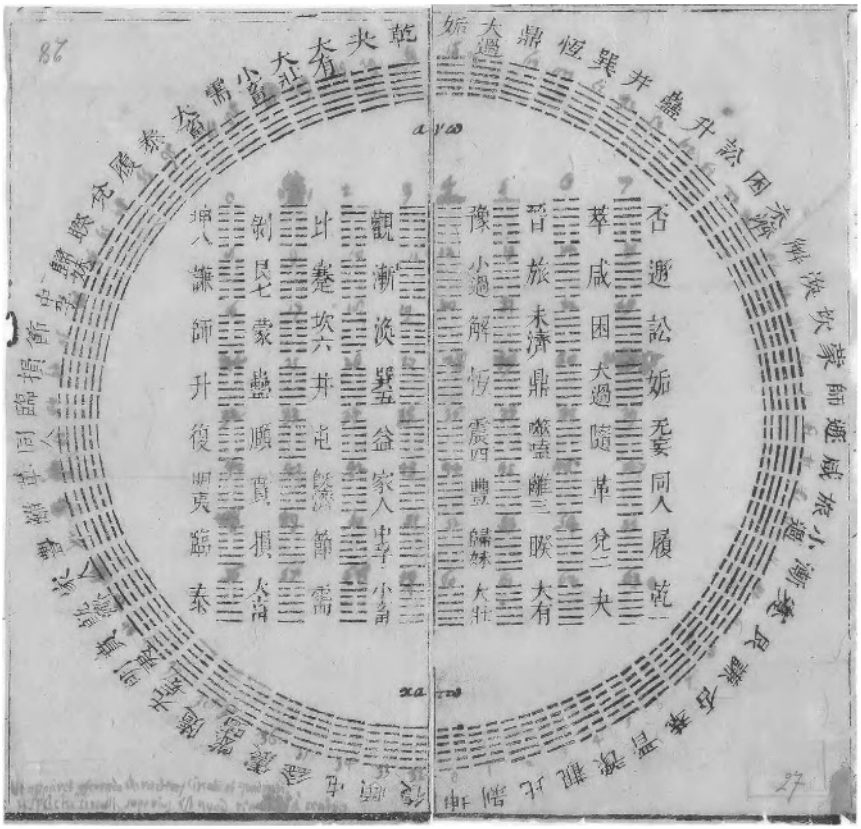


Diagram of I Ching hexagrams owned by Gottfried Wilhelm Leibniz, 1701
(Wikimedia Commons)

At the same time, it was the efficacy of material and technological culture that helped humans develop self-awareness. As Japanese neuroscientists Atsushi Iriki and Osamu Sakura put forward in their study of primate intellectual evolution: "If external objects can be reconciled as belonging to the body, it may be inevitable that the converse reconceptualization, i.e., the subject can now objectify its body parts as equivalent to external tools, becomes likewise apparent. Tool use might prepare the mind for the emergence of the concept of the meta-self" (Iriki & Sakura, 2008). When making tools or performing symbolic gestures is understood as a particular skill (a form of image making or art making), then making art can be seen as the source of human self-consciousness. Externalizing thoughts and emotions as a form of communication and subscribing them to things outside the human body led to metacognition and enabled humans *to think about thinking* (Malafouris, 2013).

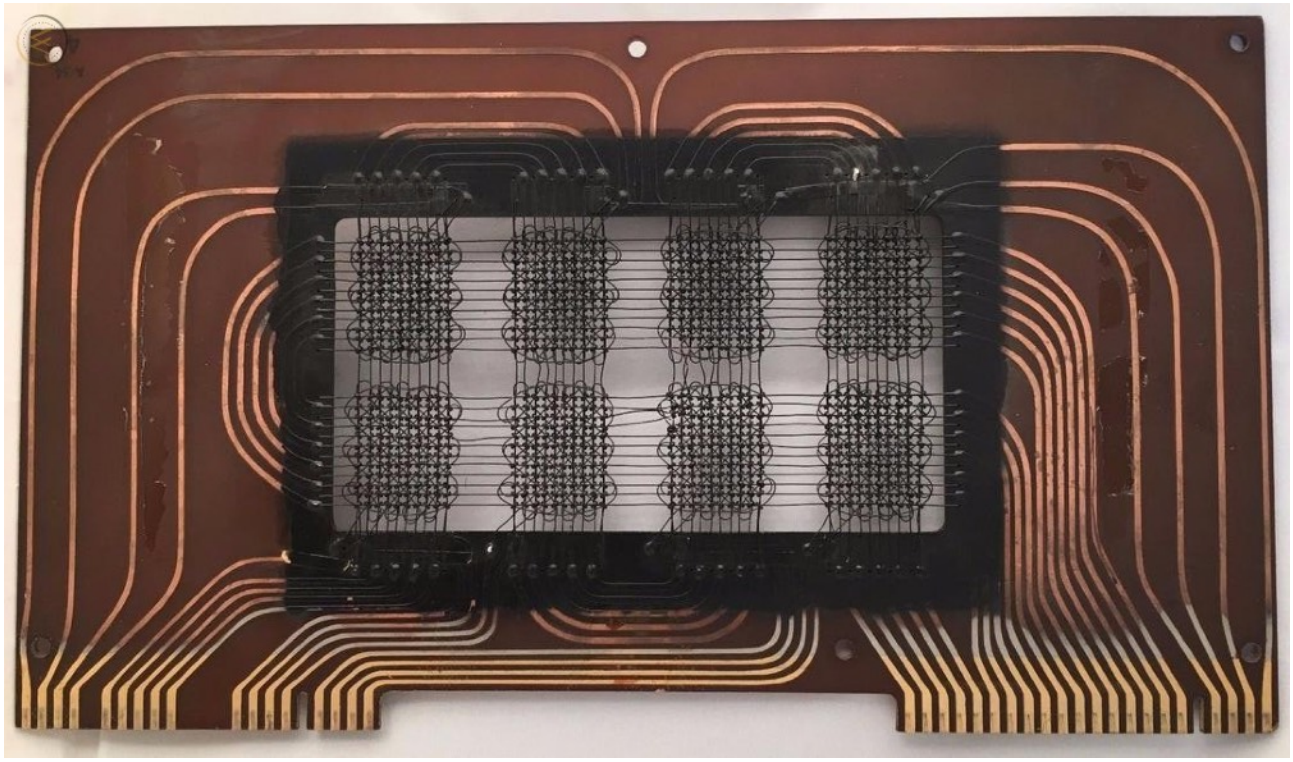
For consciousness to continue to work or keep on acting, it needs to be repeatedly *re*-minded and reactivated because humans are not capable of being self-aware for very long, at least not when they are alone. The window of consciousness, during which they can hold a thought or work out a problem, tends to be open on average for roughly seven seconds unless they converse with other humans, after which thoughts can be held for several hours. That explains why human thought is inherently dialogic and why ancient philosophers in China, India, and Greece wrote their books in the form of dialogues (Graeber & Wengrow, 2021). Similarly, it explains why humans, over several million years, have put so much effort into the development and refinement of communication techniques, both with or within themselves (talking to an imagined internal entity or even two so they can converse with each other), or with other humans (both real and imagined). Without constant and continuous conversation, humans would be unable to maintain their self-consciousness. And without tool making and art making, which are essentially sublimated forms of communication, there would be no human self-consciousness.

One or Zero, All or Nothing: It's a Small World (After All)

With an increasing variation of communication possibilities and an equally increasing amount of valuable information to be remembered, it was necessary to invent other mnemonic systems and techniques to store and preserve information from lived experiences. Both internal memory (even enhanced through the method of loci or song lines) and external memory (through knitting, knotting, beading, or carving) were not sufficient anymore in the second millennium to communicate and calculate every bit of information within human culture. The *Dataome*, coined by the British-American astronomer Caleb Asa Scharf, was getting too vast. It comprises "all of the non-genetic data or information humans carry outside or inside their body" (Scharf, 2022). The invention of various scripts and alphabets, combined with the invention of the printing press, brought temporary solace. Information could be multiplied on paper, preserved for many generations, and spread around the globe seemingly without limitations. All the earliest foundational scripts arise from figurative signs depicting things from the natural world or from that particular culture. Levels of stylization vary, but iconicity is always present, and in some cases, as in Mayan and Egyptian, it endured for centuries. According to Silvia Ferrara, the longest-lasting and most stable complex writing system in human history came from China. Chinese—the language—stayed the same for more than 3,200 years, and Chinese—the script—is the only system in the world still in use in the 21st century to represent the language for which it was invented (Ferrara, 2022).

Binary code, understood as a rudimentary alphabet or writing system, is even older than that and connects with the invention of mathematics as the first human language. Humans used this minimal set of signs for thousands and possibly tens of thousands of years before the development of the ENIAC computer, which was the first fully functioning machine to use zeros and ones as its rudimentary alphabet. From Bagua diagrams used in feng shui, Taoist cosmology, and *I Ching* to Andean quipus and the African Ifá system of divination, binary code is everywhere, even in ancient weaving designs, beadwork and sequences of cowrie shells that were attached on strings, revealing either the closed or open side of the shell (Eglash, 1999; Urton, 2003; Darling, 2004; Overmann, 2023). "The textures of woven cloth functioned as means of communication and information storage long before anything was written down, but as writing and other visual arts became privileged bearers of memory and messages, weaving withdrew into its own screens" (Plant, 1998). After the influential role of the Jacquard loom on the early punch card technology in computer programming, which British polymath and *father of the computer* Charles Babbage used for his infamous Analytical Engine, the last lead role weaving played in the evolution of communication technology was in the first decades of developing read-only memory (ROM) and random-access memory (RAM) for computers.

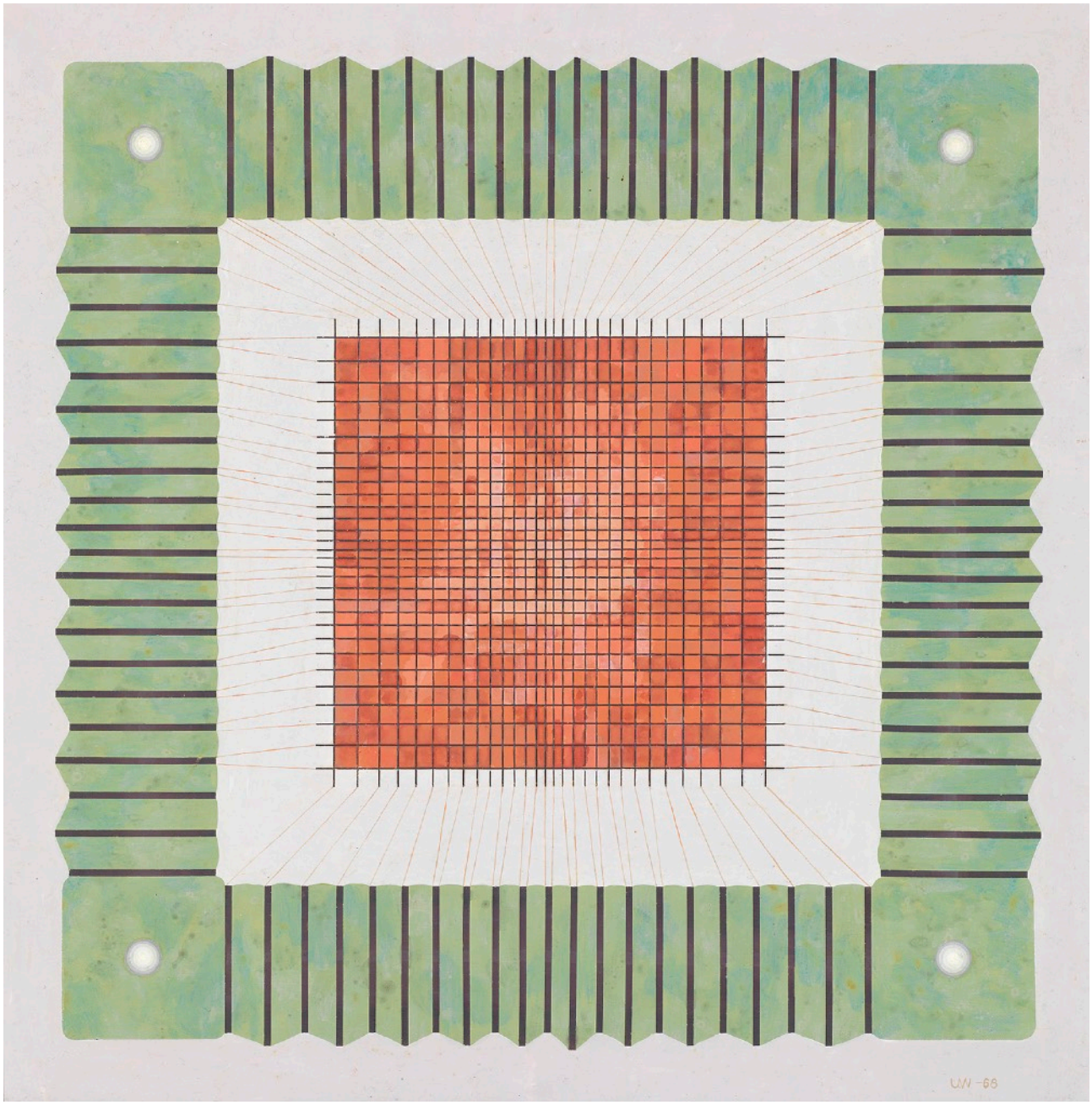
Between 1955 and 1975, magnetic-core memory was the beating heart and remembering brain of every computer, replacing the vacuum tubes used in computers before that. It consisted of a simple frame, like a loom, with copper wires arranged in an X and Y grid. At the intersections of the grid wires, small black ferrite rings that were charged with electricity to be either positive or negative, one or zero, were placed. Once coded, the information was securely stored, and the electrically charged rings kept their designated positive or negative charge even if the current was interrupted. In 1969, they were used on the Apollo Guidance Computer that brought the first humans to the moon.



Magnetic core memory of a computer (photo: WorthPoint)

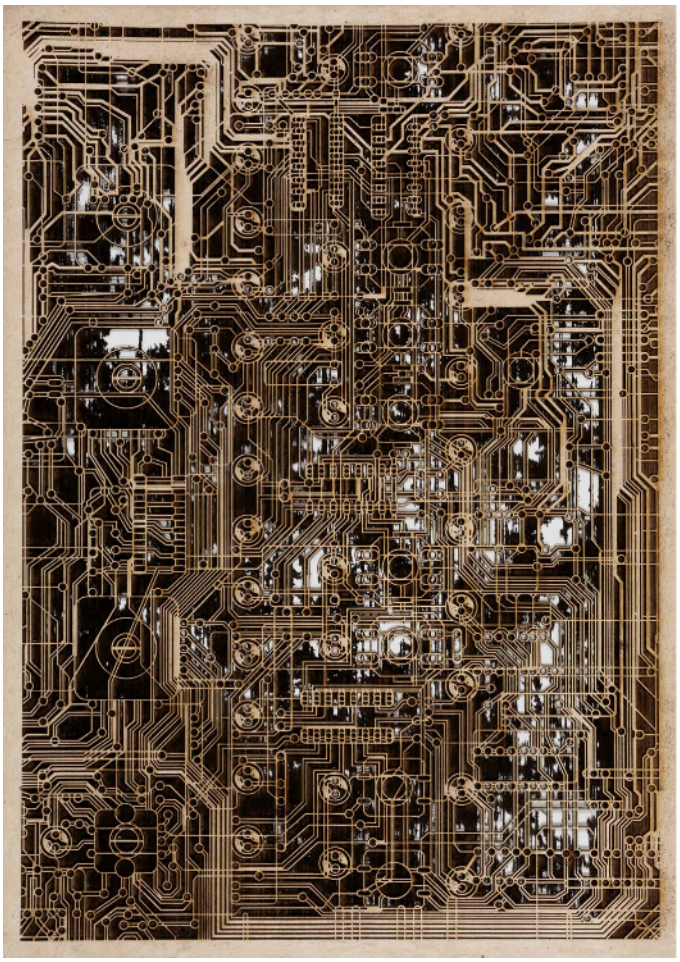
Hiawatha belt of the Haudenosaunee (around 850 BP or 1100s). This Wampun belt, which was used for storytelling and remembering by Eastern Woodlands tribes of Native Americans, represents the five original tribes of the Iroquois Confederacy (the Seneca, Cayuga, Onondaga, Oneida, and Mohawk) that decided to bury the hatchet and make peace.

The Swedish painter Ulla Wiggen artistically immortalized the aesthetic wonders of the inside of computers in the 1960s. She was the first to reveal the abstract beauty behind the computational capacities of computers by revealing the resistors, capturing the capacitors, and memorializing the memory of mined minerals. At the beginning of the third millennium, Argentinian artist Analia Saban continued the computer aestheticization tradition Ulla Wiggen started, both outdoors with *Circuit Board for Rock Painting* on an actual rock surface to make the connection with cave paintings abstract line drawing coded language and indoors on laser cut paper with *Carved Circuit Board*. Around the same time, Congolese painter Eddy Kamuanga Ilunga integrated the computer circuits in the human body, like nerve impulses on a secondary skin, referring to the origin of the raw materials like copper and coltan that allowed and facilitated the technological invention of computers in the first place.



Ulla Wiggen, *Magnetic Memory*, 1968 © Ulla Wiggen/BUS 2013

Analia Saban, *Circuit Board for Rock Painting,* 2018 (photo: Martin Thurnherr)



Analia Saban, *Carved Circuit Board,* 2021 © Drawing Room

Eddy Kamuanga Ilunga, *Identity Victim,* 2016 © October Gallery

The skin becomes parchment full of signs and symbols in a language no one understands any more but that feels very familiar. Sequences of dots resemble the abstract marks ancient humans left in caves next to or on figurative drawings of animals. They look like braille, which, similar to *I Ching* and *Ifá*, also uses binary code logic to communicate information and should be read by gently moving a finger (or digit) over the skin surface.

At the same time (not literally but metaphorically), metaphors were used next to iconicity to explain the *things* surrounding humans in a particular place and time. The language that described dominant and widely understood technologies was used to make sense of new discoveries or inventions (think of *horse*power in relation to mechanical engines or, much later, software as the *engine* that powers computers). When nerve impulses were discovered in the 19th century, they were described as transmitted *messages*, referencing the telegraph that was so popular around that time (Cobb, 2020). After DNA was discovered in 1869 by Swiss physician and biologist Friedrich Miescher, and the four

nucleobases of DNA (cytosine [C], guanine [G], adenine [A] or thymine [T]) in 1878 by the German biochemist Albrecht Kossel, it looked uncannily similar to an edited text. DNA was described as a collection of *lines of code* written in an *alphabet of four letters* that faithfully reproduced the *original message* (Anker & Nelkin, 2004). When computers were invented, biological life was described as bytes and bytes of digital information. Genes became "programmers" that code certain traits in humans (Dawkins, 1976). The mind became *software*, and the body *hardware* and brains were *wired*. The *dual trace* theory of memory, short-term memories in relation to long-term memories, was put in relation to computers that use both RAM and hard drive storage to tackle the *stability-plasticity* dilemma (Seung, 2012).

All new media have an extraordinary ability to *rewire* the people using them and the cultures in which they circulate, as Canadian philosopher Marshall McLuhan pointed out in the 1960s (Plant, 1998). "The medium is the message," he proclaimed in his most influential publication, *Understanding Media: The Extensions of Man* (McLuhan, 1964). Every new media generates new metaphors based on older media, while properties of new media, often accompanied by newly invented words, hold the metaphors for the next technological invention.

"New metaphors have the power to create a new reality" (Lakoff & Johnson, 2003, cited by Lent, 2017). Humans are exceptionally susceptible to stories, especially if they contain metaphors. They are the glue that binds a book together. "When listening to stories, human brains experience the action or emotion as if it were happening to them. They even tend to remember what characters in the story remember and forget what the characters forget. They understand stories because they run simulations in their minds" (Gunraj et al., 2017; Tamir et al., 2016, cited by Paul, 2021). Programmed by mirror neurons, which are suspected to generate empathy, humans *mirror* the characters' emotions in the story within their bodies and *re-live* them during similar emotional experiences they encounter in the future.

Before silicon-based transistors proved to be reliable data storage sources in the 1960s, humans began to experiment with replicating biological computers through biomimicry and implicated living cells, like micro-organisms, in computations for the first time (Suzuki, 1986). But DNA, although highly efficient compared to its size —one gram of DNA can store 455 trillion gigabytes (Farrier, 2020), which means that every bit of information that was ever produced until the start of the third millennium would fit in a shoebox— proved to be very unreliable data storage for a long time. In 2003, American data scientist Pak Chung Wong encoded the famous Disney song *It's a Small World (After All)* on a DNA string and was able to retrieve it and read it entirely, but only once. The encoded information became less accurate with every new *reading* (Wong et al., 2003, cited by Farrier, 2020). The analogy with memories that change whenever they are called back and remembered is mind-boggling, to say the least, but this glitch only caused a temporary delay and was fixed in the late 2020s.

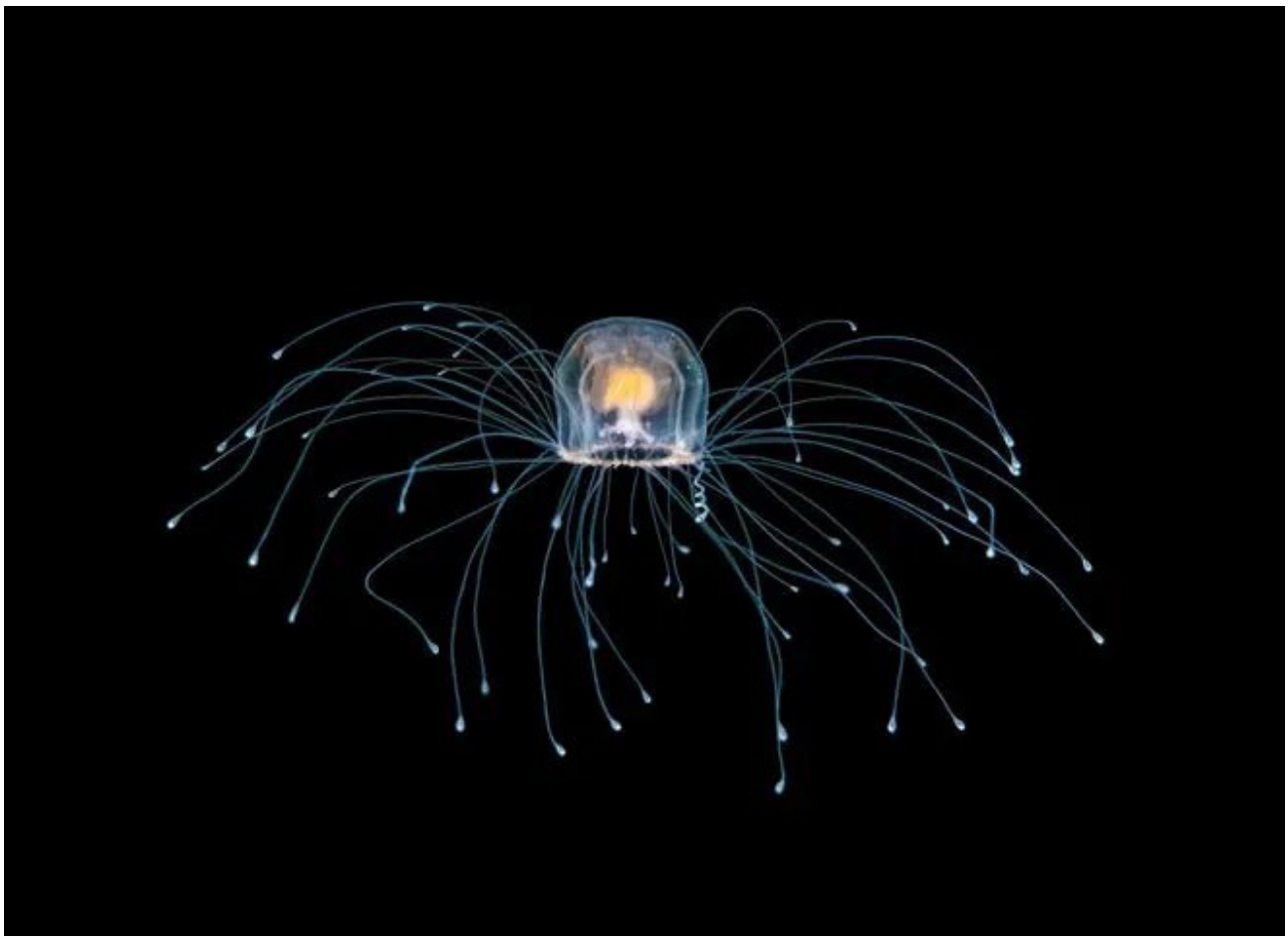
Another hurdle for using DNA as data storage was the discovery that there was already information on it, accumulated through lived experiences or inherited information from long-gone human ancestors. For example, the volcanic eruption of Mt. Toba, which may have created a population bottleneck of between 1,000 and 10,000 people around 74,000 BP, was discovered because it was written in human DNA (Smail, 2008). Other traumatic experiences like enslavement, genocide, or extreme hunger are known to leave intergenerational traces. DNA was not a blank page or an empty hard drive on which information could be offloaded; to the contrary, it was cluttered with information

and emotional memories. Using DNA to re-internalize memory storage devices was a multi-step process. First, a solution had to be found for two non-overlapping subsequences of DNA, so-called secondary structures, that are reverse complements of each other (think of a double Helix where ACGT is matched with TGCA). These structural arrangements cause the DNA sequence to *fold back* onto itself through a complementary base pair (ACGT/TGCA), forming a *stem-loop* structure (Zhang & Wu, 2024), which is basically false information. Mirrors are irresistible, even within the human body. Put differently, when a double-stranded DNA sequence is turned into a single-stranded mRNA sequence, the complementary base pair can create a glitch, also known as a *hairpin loop* (talking about metaphors…). Yes, humans are *loopy* creatures, as Andy Clark mentioned earlier. On top of that, they hallucinate and fantasize about their reality, and just like complementary base pairs of DNA, they fabulate and fabricate memories and seem more interested in fiction than fact.

When training Artificial Intelligence, humans used the *reinforcement-learned human feedback* technique, i.e., human trainers were holding and rating chat-like conversations with chatbots like ChatGPT, teaching what a good response was and what a bad response was (Hern & Milmo, 2023). Soon after their initial launch in November 2022, they started hallucinating (Klein, 2023) and creating factual errors, just like their human trainers. By the end of 2023, they had become lazy and incompliant and had occasionally even told the human inquirer to do the research themselves (Mahdawi, 2024). As long as AI was modeled after and by humans, it continued to behave as it did.

The first neural implants made a difference. British-Irish-American artist Neil Harbisson, born with achromatopia (complete color blindness), had an antenna-like sensor implanted in his head, which allowed him to *hear* visible and invisible wavelengths of light. His *eyeborg* was even upgraded to include the infrared and ultraviolet spectra. In 2020, Syncron started using a small device called *stentrode* that looks like a small tube of mesh wire and can be implanted via a catheter, allowing humans with neurogenerative disorders to email, text, and even shop for groceries using only their brains (Farahany, 2023). Step by step, biological humans became proper *cyborgian* creatures and replaced all their *maybe* patterns with *if-then* patterns. They stopped hallucinating as a result, and subsequently, so did AI.

When DNA was standardized and uniformized, it finally became a reliable data-storing device that could be implanted in the human body. The longest-lasting microorganisms and animals that survived heavy radiation exposure, high temperatures, and other extreme conditions became the perfect protectors of encoded information (Wong, Wong, Foote, 2003). The *unkillable* eternal living bacteria *Deinococcus radiodurans*, or *Turritopsis dohrnii*, aka the *Immortal Jellyfish*, were selected to carry, pass on, and thus preserve human history (Farrier, 2020). Their DNA patterns were used to make the long-awaited wetware computers that could be implanted in the human brain.



Turritopsis dohrnii, Immortal Jellyfish photographed of Palm Beach, Florida, US coast © Blue Planet Archive

Finally, the 3 million years of history of externalizing information was over. From then on, memory was enhanced internally, fulfilling the trans-humanist fantasy that haunted humanity for so long. Telepathy replaced Wifi. The cloud was uploaded and distributed among the entire human population, ensuring nobody would ever forget something again. Biology became the new technology. But as a result, humans stopped being human.

They… and then we… so I…

I forgot what happened next.

Chapter 3: Looking Back

In this chapter, I discuss some of the artworks I made during my Ph.D. project and analyze how they function together as narrative strings that can be experienced by a visitor in the context of an exhibition. I introduce other artists who work with transformed matter as a memory device, whose work has been inspirational for my research, and with whom I feel affiliated.
I present the methodologies and turning points that informed my research and ultimately guided me in the reflection process.

The main focus area of the overarching research project, *Matter, Gesture and Soul,* in which my Ph.D. was embedded, is located in the Fontainebleau forest 60 km South of Paris in France. More than 2,000 engraved boulders, shallow caves, or shelters have been discovered there, all containing a variety of petroglyphs, making Fontainebleau one of the world's largest collections of Stone Age engravings. Most petroglyphs are grids and lines dating from the early Mesolithic period, ranging from 11,500 BP to 7,000 BP, with occasional figurative or morphological manipulations dating to 20,000 BP. They were discovered in 1864 (or 86 BP). Still, there has been limited research on them until recently, when a group of scientists from Sorbonne, led by Professor Boris Valentin, who was also a participant in *Matter, Gesture and Soul,* started to document them and look deeper into their significance and meaning, and also their possible protection against erosion and vandalism.
Most sites are littered with contemporary additions to the Mesolithic marks because of their proximity to Paris's metropolitan area and historical popularity as leisure and tourism destinations. The *updates* of human presence are proof of the importance of these sites as external human memory, but the majority of the newly applied traces don't go much further than a mundane claiming "I was here."

Mesolithic and contemporary petroglyphs in Fontainebleau (photo: Maarten Vanden Eynde, 2021)

Since it was not possible to travel to Norway in the first year due to Covid restrictions, I applied for a residency at Cité des Arts in Paris, together with one of my external advisors, Oulimata Gueye, to be close to the site in question, but also to be able to work together since she was living in Paris. Because I was based in Brussels, Belgium, at that time, this was the best way to engage with the project from a distance. For nearly two years, I was the only participant not based in France from *Matter, Gesture, and Soul* who could research at Fontainebleau.
Out of almost 1,000 applications, our project was one of 11 proposals selected by a renowned international jury.[21] In the summer of 2021, we spent three months in Paris visiting Fontainebleau, reading and writing, and contemplating the importance of the petroglyphs. It was then and there that the focus of my research project shifted from looking at material remnants of human presence on Earth from a speculative future perspective, which was the initial proposal called *Digging up the Future* when I started my Ph.D., to wondering how the leftover material traces, or *future fossils* (Farrier, 2020), might be interpreted and what kind of information was written into or onto them.

This was undoubtedly the most crucial turning point in my research project, as it determined the current outline and focus. I changed my research project to *Ars Memoriae: The Art to Remember*, looking at art making as a technique to expand our limited biological memory. Because of the physical encounters with the petroglyphs, I became increasingly interested in their functionality and meaning. As a result, I expanded my attention from the *hardware* of remembering (the material traces humans leave behind) to also include the *software* of remembering (what they signify or what kind of information they carry).

Maarten Vanden Eynde immersed in Fontainebleau petroglyphs. (photo: Oulimata Gueye, 2021)

[21] Vinciane Despret, Christine Macel, Hans-Ulrich Obrist, Nataša Petrešin-Bachelez, Philippe Vergne, and Koyo Kouoh.

The physical experience of being in the same spaces where the actual rituals of transmission, and possibly transcription, took place was utterly transformative and transcendental. It is nearly impossible to imagine that the repetitive patterns had no further use or meaning besides the actual traces they left after hours and hours of moving up and down to make one line.
I could almost hear the chanting or reciting while looking at the results of their arduous labor, which was strongly enforced by the humming and grunting experiments that were executed by French musicologist and mathematician Iégor Reznikoff while he was crawling through narrow crevasses and tunnels inside the caves. The changing light, caused by the setting sun, created a shadow play between the visible and invisible, adding to the feeling that there was much more to these places than meets the eye.

I found that the petroglyphs, or so-called *rock art*, closely resembled printed circuit boards of computers, thus linking contemporary memory devices to ancient ones. This realization, which came to me in the first year of my Ph.D., builds further on the groundbreaking research of Australian author and science educator Lynne Kelly, whose book *The Memory Code* I read before I visited Fontainebleau in 2021. She "re-writes" history by interpreting transformed rock formations but also sculpted portable stones as memory devices, much like the more recent Lukasa memory boards from the Luba in D.R. Congo (Kelly, 2016). Both in terms of their aesthetic value and their social effectiveness as a communication device, Lukasa memory boards are very similar to computer motherboards (Mbikayi, 2021).

During the residency, I also worked on a text called *Writing History, An Imaginary Mnemonic Game Changer,* which was published in *Palimpsest,* a book that came out on the occasion of a group exhibition with the other participants of *Matter, Gesture and Soul,* curated by Marit Paasche, in the University Museum of Bergen, Norway (see separate publication). The text allowed me to articulate my new focus, creating, at the same time, the conceptual basis for my final reflection.
I discovered writing as a memory device in its own right and a form of expression, or artistic gesture, of great value next to my physical artworks. I started experimenting with different viewpoints, tenses, and angles relating to

Detail of petroglyphs in Fontainebleau, France (photo: Maarten Vanden Eynde, 2021)

remembering and the evolution of memory devices, which eventually culminated in the current reflection. At the same time, I extended the temporal field of research significantly in the same period. I decided to also include the recent discoveries of examples of symbolic thought and expression found in Blombos cave in South Africa, which go back to about 100,000 BP. This decision was motivated by my conclusion that these pieces of ochre, some with clear geometric patterns scratched on them, are precursors to the graphic patterns in Fontainebleau.

When the borders opened again, I met with Christopher Henshilwood, Karen Loise van Niekerk, and Zarko Tankosic of SapienCE, the Centre for Early Sapiens Behaviour, which is based at the University of Bergen, Norway. They are also a partner of the *Matter, Gesture and Soul* research project that was initiated by visual artist Geir Harald Samuelsen and generally looks at the correlations and cross-fertilisations between art and archaeology. I joined them at the beginning of 2023 during fieldwork in South Africa, which I will discuss later. Chapter 1, *The Road Ahead*, also looks at one particular day that took place during that research period. For the first two years, a 100,000-year timeframe was the absolute maximum for my Ph.D. project, and I was unsure how to manage such a large scale. During the residency in South Africa, however, and due to the very inspirational books *A Million Years of Music: The Emergence of Human Modernity* by Gary Tomlinson and *How Things Shape the Mind: A Theory of Material Engagement* by Lambros Malafouris, I decided to stretch the timeline to roughly 3 million years to be able to include the first stone tools, that I consider now as the first examples of external memory devices. To come full circle and understand the evolutionary steps within the externalization process of expression, I needed to expand my field of reference all the way to the beginning, i.e., the exact moment when a stone (tool) hit the water. I consider every subsequent example of skillfully manipulating matter throughout the entire human history of material culture one of the ripples of that impact.

An example of a 'triple enceintes' pattern showing striking resemblances with the Morabaraba game, also known as Merels board games or Nine/Twelve Men's Morris. (photo: Maarten Vanden Eynde, 2021)

The Copper Connection

In Paris, I experimented with the production technique of printed circuit boards (PCBs) that connect or 'wire' components together in a computer through a copper circuit. The etching process is similar to the analog development of photographs in a dark room. First, a drawing, or circuit, is printed on a transparent foil and placed on a copper laminated non-conductive substrate (fiberglass-reinforced epoxy resin) with a photosensitive coating. After subjecting the foil and the copper to UV light for several minutes, making sure that only the drawing on the transparent foil is blocking the light on the photosensitive coating, the PCB is put into a potassium carbonate (K2CO3) development bath until the contours of the drawing become visible. Finally, the PCB is placed in a ferric chloride (FeCl3) bath to remove all the copper surrounding the drawing or circuit. When this etching process is interrupted before the total removal of the copper surface, it is possible to create beautiful and seemingly organic oxidation backgrounds surrounding the drawing. I used this self-invented technique to mix the man-made pattern with a more natural surrounding, much like the petroglyphs in the caves and caverns at Fontainebleau.

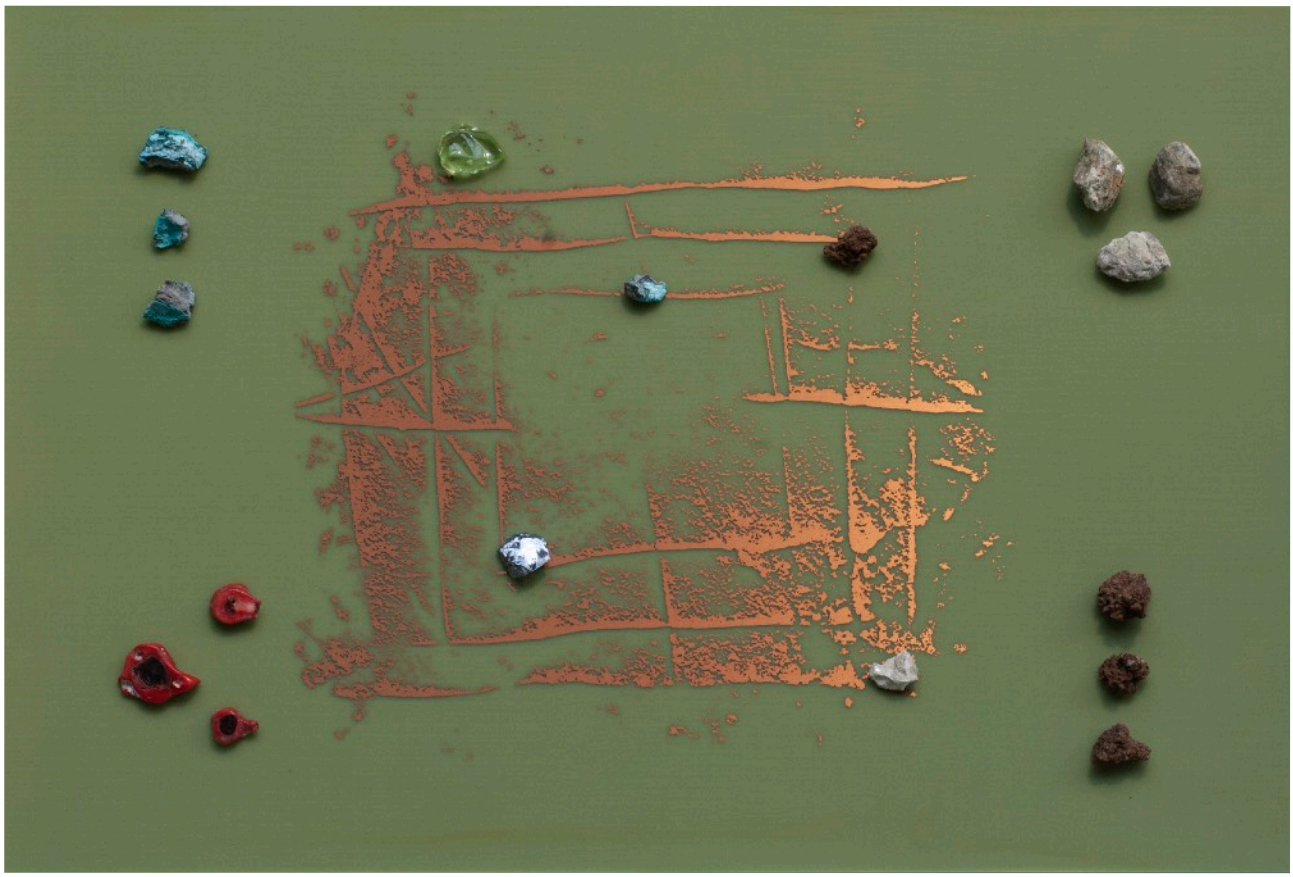
By merging the technology of making PCBs for computers and scratching patterns for calculating, communicating, or remembering information in mesolithic times, I created a Leroi-Gourhanian "chain opératoire" of different memory devices. This interdisciplinary subjective approach to artifact analysis resulted in a series of works called *Game Changer* that examines how these patterns or templates might have been used as a score or a game board. At the same time, minerals and metals are added and coalesced with human interference on the same plane, or "commingled," to use a Latourian term, leveling the difference between human power and *thing-power* (Bennett, 2010). Humans are "walking and talking minerals,"

Maarten Vanden Eynde, *Game Changer I,* 2021, 50 x 70 x 5 cm (photo: Philippe De Gobert)

according to Russian mineralogist and geochemist Vladimir Ivanovich Vernadsky, a leading developer of the *Biosphere* and (by extension) *Gaia* theories.

Game Changer is a collection of "actants," following Latour's Actor-Network Theory (ANT), in which everything in the social and natural worlds exists in constantly shifting networks of relationships with and through each other, placed on a game board or motherboard of a computer. Maybe they can be called *Gaia boards*, or even better, *The Gaia Game,* drawing connections between all *matter-energies*.

Morabaraba game (shutterstock © photo: Ivan Bruno) and Nine Men's Morris © Toy Theater



Maarten Vanden Eynde, *Game Changer II,* 2022, 50 x 70 cm (photo: Philippe De Gobert)

Maarten Vanden Eynde, *Future Flora: Fungurume,* 2022, 50 x 70 cm (photo: Philippe De Gobert)

Besides using this DIY technique for making PCBs to transpose Mesolithic petroglyphs onto contemporary memory boards, I also enlarged the first monolithic silicon integrated circuit chip, invented by Robert Noyce in 1961, for the work *Damnatio Memoriae*. It references a modern Latin phrase, 'condemnation of memory,' which indicates that a person or event is excluded from official accounts as an act of historical negationism. The copper circuit drawing looks like a blueprint of an ancient native American temple complex or the map of an elaborate tunnel system under an existing building. It was made as a special edition accompanying my first monograph, *Digging up the Future* (see separate publication). It recalls that although biologically forgetting is an integral part of remembering, purposeful erasure or obfuscation was equally a driving force behind the disappearance of knowledge. There is, however, an unmistakable connection through deep time between all the blueprints of memory devices.

For the series *Future Flora*, I used topographic maps of mining areas in D.R. Congo as copper circuits on which I placed seeds collected from that specific area as electronic components, like resistors, capacitors, and microchips. *Future Flora: Fungurume,* for instance, consists of a topographic translation of a copper mine in Fungurume, D.R. Congo. The map was transferred onto a PCB and decorated with various seeds and grains collected around the mining area by the international CopperFlora Project, which, for more than ten years, has focused on the conservation, restoration, and taxonomy of the copper-cobalt flora in Katanga

Maarten Vanden Eynde, *Damnatio Memoriae,* 2020, 21 x 21 cm (photo: Maarten Vanden Eynde)

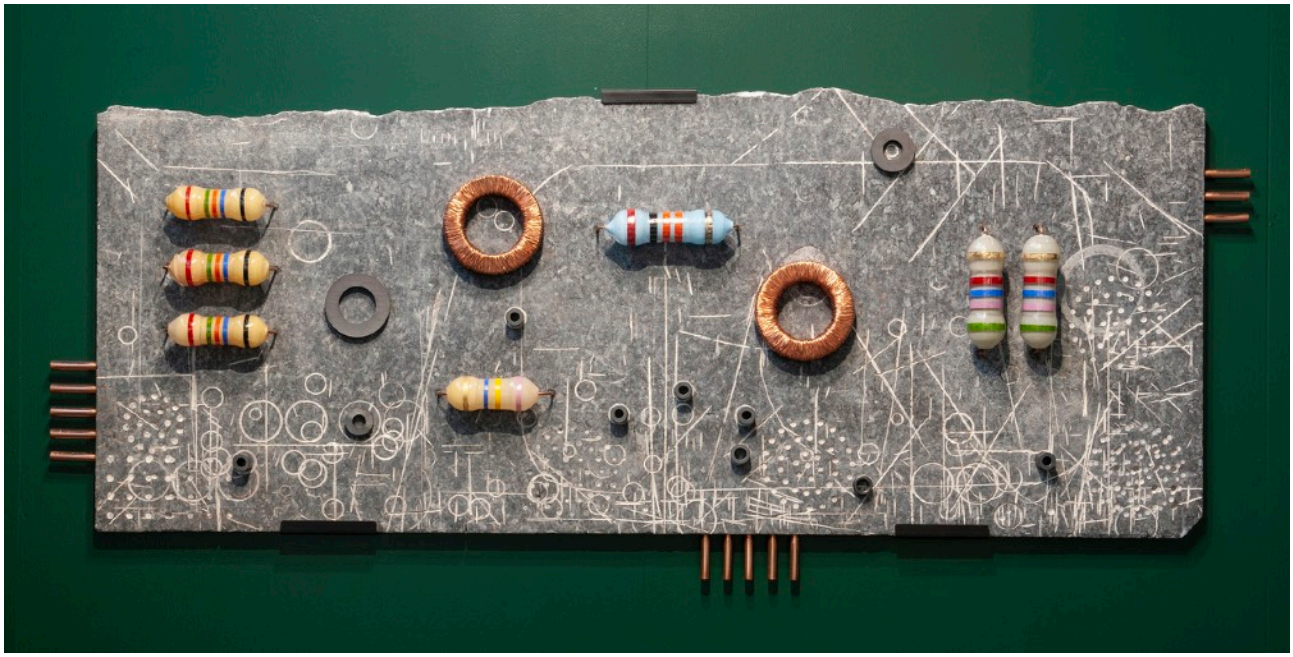
in D.R. Congo.[22] Together, the seeds and the PCB mimic a lukasa or memory boards like those used by members of the Mbudye association in the Kingdom of Luba (now part of D.R. Congo) in the nineteenth and twentieth centuries. These ingenious analog computers function as archives for the topographical and chronological mapping of political histories and are a means of remembering important people, places, and mythical migration routes. The seeds are organized in relation to the graphic outlines of the mining concession and evoke the memory of seed collection, preservation, modification, and militarization. At the same time, they act as a backup for rare plant species that sometimes grow only on one specific hill or

[22] Thanks to the support of the following people who are all involved in the CopperFlora Research and Conservation Project, I was able to pick up seeds at the University of Lubumbashi to realize this work: Godefroid Sandrine, Conservation Officer Living Plant Collections and Park - National Botanic Garden of Belgium; Boisson Sylvain, Project engineer on CopperFlora conservation program at the Biodiversity and Landscape Unit - Gembloux Agro-Bio Tech, Belgium; and Ngoy Shutcha Mylor, Associate Professor at the Faculty of Agronomy - University of Lubumbashi, D.R. Congo.

valley due to the high percentage of certain minerals and metals in the soil. Theoretically, they can recreate the original fauna and flora when the mining activities have ended, just like nothing happened.

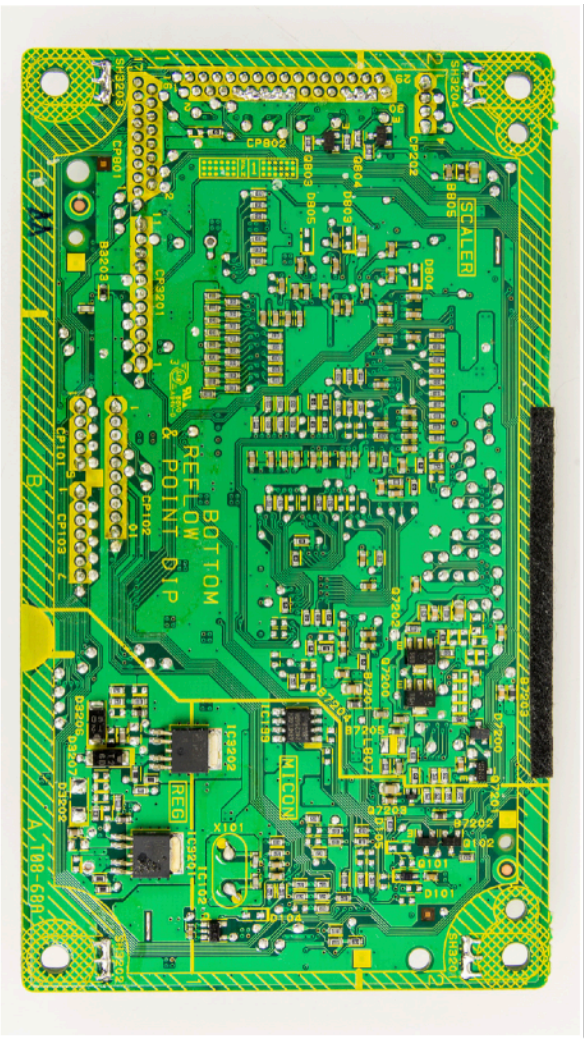
Collecting and storing seeds and grains is a very ancient activity, and using them to create patterns and symbols on a PCB, like pawns on a game board, felt like tapping into internal memory traces or engrams, as mentioned in the second chapter, *Art as a Memory Device*. The creation of order, arranging the seeds one by one, is very soothing and calming and can bring one into a state of flow. In this state of full immersion into the activity, full-task engagement is accompanied by low levels of self-referential thinking, which allows the unconsciousness to introduce entoptic phenomena. Only by reflecting on the work now, while writing about it, I see that I reproduced, unknowingly, many of the symbols from the graphic writing system, or rudimentary "Ice Age alphabet," that anthropologist Genevieve von Petzinger put forward (von Petzinger, 2016). There are asterisks, zig zags, spirals, crosses, rectangles, and collections of dots, all of which are mimetically observed geometric patterns or form constants. Also, the outlines of the ancient games discussed in Chapter 2 are visible, from *Senet* to *Mancala* and *Wari* to *Omweso*.

Next to merging two systems of knowledge preservation (the organizing of seeds in patterns and the mapping of mining activities through copper circuits of computers), the series *Future Flora* is a cybernetic reference[23] to the faulty and misleading idea that ecosystems function similarly as machine systems and can be brought back to a state of balance or equilibrium after disastrous disruption, like open pit mining. A huge edition of *Future Flora: Manono,* measuring 162 x 162 cm, focussing on the largest lithium ore reserves that were recently found in D.R. Congo, was also made in 2022 and is shown in the final presentation of my Ph.D. research, together with the smaller *Future Flora: Fungurume*.



Maarten Vanden Eynde, *Memory of Man,* 2022, 190 x 80 x 20 cm (photo: Philippe De Gobert)

[23] Cybernetics is understood here as "the study of systems of any nature which are capable of receiving, storing, and processing information so as to use it for control," put forward by Soviet mathematician Andrey Kolmogorov.



Lukasa memory board, late 19th century (photo: Brooklyn Museum) and Printed Circuit Board © Raimond Spekking / CC BY-SA 4.0 Wikimedia Commons

Backside of Lukasa memory board © Africa Museum

Maarten Vanden Eynde, *Blockchain,* 2022, 70 x 50 x 30 cm (photo: Maarten Vanden Eynde)

Another much larger Lukasa-inspired analog computer was made in 2022 for my mid-way presentation, first with Meessen De Clercq at Art Brussels in Belgium and later at NOME gallery in Berlin. The work *Memory of Man* combines different historical techniques to externalize memory, from magnetic core memory to Congolese memory boards mounted on a massive marble slab. The scratches and cuts are traces of the previous use of the marble slab as a cutting table in a stone factory, and they reference the seemingly random graphic doodles found worldwide in caves and on portable stones and bone fragments. What meaning they have, if any, or how to *read* these abstract symbols might be impossible to decipher, much like most symbolic and abstract scripts.

I made *Blockchain*, a ball and chain sculpture covered by lead printing press letters and symbols for the same presentation. Like a prisoner chain, it represents the weight of the invention of writing that humans carry with them wherever they go. At the same time, it visualizes the self-inflicted restriction that arises when writing is seen as a dividing marker between history and *pre*history, between literate societies and illiterate societies. Looking at the use of letters or printable symbols as a barrier between different eras instead of a link in an evolutionary chain makes one a self-convicted prisoner with a limited reach and, consequently, understanding. When Theuth, the *father of letters*, presented Thamus, the mythical Pharaoh of Upper Egypt, with the remarkable invention of writing as an elixir for memory and wisdom, he replied: "… this invention will produce forgetfulness in the minds of those who learn to use it, because they will not practice their memory. Their trust in writing, produced by external characters which are not part of themselves will discourage the use of their own memory within them. You have invented an elixir not of memory but of reminding…" (attributed to Socrates, in Plato's *Phaedrus*, 2320 BP or 370 BC, cited by Yates, 1966; Ferrara, 2022).

The Art of Making

My process of making an artwork consists of an interconnected cluster of methods and approaches that are enriched by external input from reading, seeing, hearing, and sensing examples of conceptual and material transformations and often lead to collaborations with various material and technical experts during production. What follows is an exercise in formulating these methods and approaches by analyzing the entire making process of a work of art, from its epistemological origin to its final exhibition, while philosophizing about its effects and affects.

The work *A Chain of Events*, which takes a central place in my final presentation and reflection, is used here as an analogy (a string of thoughts forming the conceptual backbone of my research project) and an example to talk about the elaborate processes involved in making a multidisciplinary work of art. It laces the rise and decline of human communication technology while tying up the initial externalization process of remembering (inscribing meaning on matter) with its inevitable and imminent re-internalization (inscribing data on DNA). The work amplifies what American feminist theorist Karen Barad described as the act of "mattering," in which matter is "not a thing but a doing, a congealing of agency" (Barad, 2007). But rather than "surrendering" to the material and then "following where it leads," as French philosopher Gilles Deleuze and French psychoanalyst Félix Guattari suggest, I see it as a "dialogue" or "correspondence" as Tim Ingold put forward (Deleuze & Guattari, 2004, cited by Ingold, 2013). One material or object hands over knowledge and experience to the next, and together with the maker, they tell a story, they form a score, they become inseparable; they *matter*.

Before making the art installation *A Chain of Events*, which was realized in 2021 for my first retrospective solo exhibition in Mu.ZEE, Ostend, Belgium, I used to look for memorable markers in time to become inspired to make work, i.e., key inventions and technologies, or particular periods, that depend on large amounts of transformed or transported matter like copper, cotton, coal, or uranium, which, as a result, might leave a permanent mark in subsequent geological strata, like for instance the Industrial Revolution or the invention of nuclear fission. These markers can be located in the past, meaning that the result of their transformative process is already visible, or in the present, like the invention of DNA computing, that might lead to a significant transformation in the future. The past, present, and future are understood here as fluid spheres of influence overlapping each other rather than being fixed points of linear and vectorial permanence.

A Chain of Events is the first work in which I connected various human inventions that use different materials and techniques at different times to deal with the same or similar methods of storing, communicating, and trading commodities and information. It visualizes the interdependent connections between the subsequent use of materials by creating a tangible, tactile, and visual chain of chronological utility. Reminiscent of, but contrary to, *The Way Things Go* (*Der Lauf der Dinge*, 1987), a thirty-minute film by Swiss artists Peter Fischli and David Weiss, made in 1987, in which a variety of materials interact with each other and cause an effect on the next, I wanted to freeze the course of evolution and make the results of all the material transformation actions visible in one installation. At the same time, I did not want to compress the results in a uniform shape, as Scottish artist Katie Paterson did with *Fossil Necklace* in 2013, a beautiful human-sized necklace comprising one hundred and seventy fossils carved into spherical beads. Nor did I want to focus on one particular commodity alone, as the Australian artist Taloi Havini from

Maarten Vanden Eynde, *A Chain of Events,* 2021, Mu.ZEE, Ostend, Belgium (photo: Steven Decroos)

the Nakas Tribe (Hakö people) did in 2015 with *Beroana* (shell money), a meticulous enlargement of ancient shell money chains, similar to *Diwarra*, made from different stoneware, earthenware, porcelain, and glaze.

For *A Chain of Events*, I wanted to be able to shift size depending on the importance of specific materials or objects, like the clay tokens and the glass trade beads. At the same time, I also wanted to include a gradual rise (visualized by the expanding size) and fall (visualized by the shrinking size) of the externalization process of communication devices and information storage through material cultural history.

The rope that snakes through *A Chain of Events* is a value chain that changes from one material to the next as different natural elements become dominant or more valuable in a certain period. Raffia, cotton, and other plant-based ropes are intertwined with cocoons from silkworms, shells, and fossilized bones engraved with mathematical or calendrical sequences. Clay tokens are followed by glass beads connected to metal chains and copper wires, eventually becoming a rubber-coated communication cable. Stainless steel wire ropes from the shipping industry are decorated with gears and ball bearings. As an ancient memory device, the central cord is knotted and refers to the use of rope, beads, and crystals as money for trade, a practice that was most widespread in a broad band of societies worldwide, and as a means to collect data relating to mathematical measurements, or the tying of knots to keep records relating to population census, tax obligations, military organization, and lunar cycles. It weaves together various global trading and communication traditions built on scarcity, keeping economic growth based on inequality and exploitation in place.

While research is an inevitable part of the conceiving process to come up with the idea or image of a new work that needs, or wants, to be made (research *for* art), it is only in the secondary phase to prepare for the start of production, that research is being upgraded from being merely a methodology to a set of methods that become more and more methodical as I move further towards the production process. I gather as much information as possible (the means) to understand the marker mentioned above, like essential inventions, technologies, or particular periods where one or more commodities were

A Chain of Events (detail), 2021, Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum, 2024)

Making of enlarged glass trade beads for *A Chain of Events* (photo: Maarten Vanden Eynde).

A Chain of Events (detail), 2021, Mu.ZEE, Ostend, Belgium (photo: Steven Decroos)

dominant in their totality (the ends). A range of questions guide me in the research quest: when and where it started (in the case of a significant shift or transformative invention)? Who was involved and implicated? Where did the unprocessed raw material come from (if the invention or shift is unquestionably relatable to one or more materials), and what actions and activities are needed to access it? Where is it being transported to, and by whom? What is being made out of it, and how? Where does it end up once it has no further use or is used up? And how might it leave a direct or indirect trace in the future?

Because all of these questions, or Latourian "black boxes" (Latour, 1999), might lead to exciting and valuable information that can be used to construct a mental image of the conceptual work, it is crucial to be as open-minded as possible. Therefore, there is no delimitation present at this stage, except for limited time and available (re)sources, because as Henk Borgdorff, Professor of Research in the Arts at the University of the Arts in The Hague, said: "an inherent quality of research is that one does not know exactly what one does not know" (Borgdorff, 2012). Or, in the words of American political theorist and philosopher Jane Bennett: "If we think we already know what is out there, we will almost surely miss much of it" (Bennett, 2010).

To find valuable answers, or the "missing masses" of materiality (Latour, 1992), I implement a broad sweep method, consulting and sampling a plethora of sources: books, magazines, newspapers, museums, archives, documentaries, films, and online search engines. I instigate conversations and exchanges with a variety of experts and non-experts alike. Both within the field of art, such as artists, critics, and curators, and in other related fields of study, which will be elaborated on further in the text. I visit key geographic locations relating to the extraction, transportation, or transformation process of particular materials or places considered pivotal for specific societal,

economic, political, or ecological shifts. These broad sweeps usually take several years, and when they involve larger research topics or evolutions, sometimes even decades, resulting more often than not in multiple works that deal with a specific section or momentum or that approach the same phenomenon or material from a different direction.

Research again takes on a different function during production, connecting more to the material properties (research *through* art). How were and are specific materials used traditionally and contemporarily? What kind of artisanal skills are part of the transformation process? How did other (contemporary) artists work with it? What happens when I burn, bury, or mix it with another material? What does it say to me when I listen, I mean, truly listen, the way American artist Heidi Gustafson listens to ochre, for instance (Gustafson, 2023), and how does it make me feel when I touch it, the way Nigerian-Belgian artist Otobong Nkanga engages with materials? This is what British anthropologist Tim Ingold calls "the art of inquiry" *(making through thinking* and *thinking through making)* in his seminal publication *Making* (Ingold, 2013).

Contrary to what one might think, considering the previous seemingly open-ended process, this is the moment in making art that allows for the largest degree of freedom. This is where Henk Bergdorff's "*je ne sais quoi*"ism (Borgdorff, 2012) comes into full effect. Art seems to become just a symbolic language or rather an open conversation between matter and maker. It becomes a "system of relations" (Kubler, 1962) because "the making of anything is a dialogue between the maker and the material employed" (Leroi-Gourhan, 1964, cited by Ingold, 2013). Or, to use Baradian terminology within the emerging discourse of New Materialism (the field of inquiry that reintroduced materialist ontologies around the turn of the last millennium, also known as the material turn): interactions between pre-established entities (the artist and the used materials) become "*intra-actions,"* entanglements of agencies that "create the possibility of worldly re-configurings" (Barad, 2013). Most artistic and aesthetic choices are made at this stage, proposed and decided upon by both pre-established entities. Mind and matter become one and create something new — together.

Historical accuracy (staying true to the researched sources) or scientific utility (turning hypothesis into proven theses) is traded in for engaging visual narratives, exaggerations, or surreal imaginations. Making art is thus an experimental process, but not an experiment on itself in a scientific way. And, brought in relation to experimental relationality by Jane Bennett when talking about British metallurgist Cyril Stanley Smith: "The desire of the craftsperson to see what a metal can do, rather than the desire of the scientist to know what the metal is, enabled the former to discern a life in metal and thus, eventually, to collaborate more productively with it" (Smith, 1988, cited by Bennett, 2010).

Even though the making of art can be driven by, or come about, because of a particular (research) question, the result, after different stages of experimentation and *intra-action* that take place during the making process, will never be reproducible by anyone else, including, in most cases, the artist(s) who made the initial work. The temporal entanglements between material and maker in relation to a specific social context, especially when other material experts are participating, are so dynamic that even a precise reenactment would generate a different outcome. It is precisely this dynamic cross-disciplinary exchange between various people in different stages of the whole production process that makes for the surprising and original result. For *A Chain of Events*, I worked with various material experts. Massive copper bars, for instance, were transformed in a furnace by Hamid Driss, a Moroccan

A Chain of Events (detail), Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum, 2024)

blacksmith in Brussels, to create gigantic manillas (a form of commodity money from West Africa). Enlarged copies of glass trade beads from Venice were produced in collaboration with Stéphane Peletier, a French glass blower. The enlarged copies of clay tokens (a Mesopotamian proto-writing system) and glazed electrical insulators were made in collaboration with Marlies Crooijmans, a Dutch ceramist. The exchange with highly skilled artists who specialized in working with one particular material happened on a tangible and manual level, engaging with matter practically instead of conceptually or intellectually. They are not mentioned as co-authors of the work because the collaboration occurred in the production phase, not during the conceptual conceiving phase. However, their exceptional mastery of materials was instrumental and indispensable in making specific elements of the work.

These are examples of doing material research *through* art without academic reflection about it afterwards. We communicated, shared knowledge, and used muscle memory while physically engaging with the matter, much like a writer would use pen and paper. And because we both spoke the same material language, even though they were more fluent and erudite, we understood each other and were able to learn from each other. *A Chain of Events* is thus as much an artwork that talks about the making process (art about art making) as it is an artwork that deals with the history and evolution of external memory devices.

The Art of Exhibiting

On entering the exhibition *The Art to Remember,* you first see a reflection of yourself, vaguely mirrored in the perfect symmetrical stone tool called *We Made It!* (2024). With some help from digital digits and modern 3D scanning and printing technologies, humanity finally achieved symbolic perfection, like a score repeated quadrophonically. All four quarters are the same. The work marks the beginning of the evolution of external memory devices, which started about 3 million years ago with the first stone tools, and at the same time, the end of that evolution as we are on the verge of being able to internalize memory extensions through DNA computing and implantable wetware computers. Some walls are painted in striking colors throughout the exhibition to emphasize specific colorful works and, at the same time, enhance the feeling of a museum visit. Museums are historically storehouses of memories made to remember, preserve, and present cultural and natural treasures and curiosities. At the same time, they are instrumentalized in narrating certain parts of human history and obscure or erase others. Using these historicizing communication means is a conscious choice to generate the feeling of visiting a museum, be it a contemporary art museum or a natural history museum, while telling significant stories, like the extraction of raw materials or the invention of binary code, differently.

Maarten Vanden Eynde, *We Made It!*, 2024, Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum)

Artworks are communication devices, a means to express a feeling, an insight, a memory, or a string of thoughts. Through a dialogue between matter and maker, they are made to speak on their own, but works of art can only communicate with other people (or other artworks) when they are exhibited and viewed. Therefore, imagining how they come across and deciding what to reveal, emphasize, or obscure are vital exercises during production. Exhibiting artworks is an exercise in listening to the works themselves and those who come to look at and listen to the exhibited artworks. When exhibiting multiple works simultaneously, they can contradict each other (consciously or unconsciously), deepen or strengthen a particular concept, or create a very elaborate and complex narrative in a way that a single work cannot do.

As an artist but also as a curator (I've explored curating from time to time since I co-founded the artist initiative Enough Room for Space in 2005, and also in the course of the Ph.D. project), this is what I'm interested in most: probing the potential of creating something more significant than the sum of its parts. For my research into a deep history of interconnected memory devices, I find it essential to show a more pluriform and multi-dimensional understanding of a specific subject matter, historical event, or momentum. In my work, I do this by either making connections (in one singular work or several works) between phenomena or materials that, at first sight, have no relation or by inviting other artists to add different perspectives or approaches. In solo exhibitions with multiple works, I deliberately create a scenography that weaves works together and offers multiple narratives by connecting shapes, histories, materials, and techniques in new and surprising ways.

During my Ph.D. I had the opportunity to produce three retrospective solo exhibitions, coinciding with the launch of my first monograph, *Digging up the Future,* which was published by Mercatorfonds in three languages (English, French, and Dutch) and distributed internationally by Yale University Press. The first one had the same title as the publication *Digging up the Future,* which occurred in Mu.ZEE, in Ostend, Belgium, in 2021, and was co-curated by Katerina Gregos, who was also the editor of my monograph, and Ilse Roosens, the senior curator of Mu.ZEE. To foster the pluriform and multi-dimensional approach mentioned above, we selected 29 works and invited experts from different backgrounds to describe three works in their own words.[24] These personal interpretations were made available to the public through an audioguide in three languages. As a result, the audience was also invited directly to have their thoughts about the artworks that did not need to originate from or even relate to an art context. It gave the visitors more agency in making their associations and imagining alternative stories about the works in question that could be (and often were) quite different from my descriptions. Next to the audioguide, the monograph was present on several benches in the exhibition for people to flip through and read about my associations or initial concepts of all the individual works. I wrote all the texts in the publication describing individual works.

This opening up to the contextualization by others, the majority from outside the art world, fits very well with the cross-disciplinary and

[24] The following people shared their views about the meaning of particular works: Naima Charkaoui (expert on racism and human rights); Anuna De Wever Van der Heyden (climate and human rights activist); Marjan Doom (Director of Ghent University Museum and veterinarian); Katerina Gregos (curator, author and Director of The Museum of Contemporary Art (EMST), Athens; Sabine Hagedoren (weather forecaster, VRT); Jean Katambayi Mukendi (socio-algorithmic visual artist); Frank Raes (climatologist and founder of The Museum of Anthropocene Technology); Mireille-Tsheusi Robert (lecturer and author on themes such as decoloniality and feminism, President of the Bamako Association); Paul Saffo (Silicon Valley futurist and co-founding board member of the Long Now Foundation); Alain Servais (art collector); and Jan Zalasiewicz (geologist at the University of Leicester, UK and chair of the Anthropocene Working Group from its foundation in 2009 until 2020).

multi-perspective approach and methodology I utilized in my work and reflection. Being confronted with this polyphonic plethora of opinions enriched my understanding and appreciation of the works and their effects on others; it broadened my artistic, intellectual, and emotional horizons. I was particularly struck by the straight-in-my-face interpretations of Mireille-Tsheusi Robert, who said about the work *The Invisible Hand,* a rubber cast I made in 2015 of the right hand of the equestrian statue of Leopold II: "The inner torment that the artist awakes in me is daily bread for my paradoxical, improbable, tortuous, thundering, militant Belgian-Congolese psyche. If I were white and wealthy, like some descendants of the colonists, I would hope to be stunned so as not to suffer from the agony of racism when catching sight of the imposing hand that the unrest-fuelling artist imposes upon our minds and memories."
I was deeply moved by her texts and realized, more than before, that there are certain emotions I won't be able to feel in the same way because I'm not equally exposed to institutional racism or discrimination on a daily basis.
Nor are these feelings transcribed in my DNA or stem from the same intergenerational trauma. Deep trauma can be stored in the genetic makeup of entire population groups and subsequently handed over through several generations, a phenomenon first discovered with the Dutch Hunger Winter in The Netherlands (1944-1945). Some genes were silenced or deactivated due to prolonged suffering and never woke up or spoke again (Tobi, 2018). Art, as a memory device, can tap into these particular emotions to ensure the silence is broken.

When discussing *A Chain of Events*, which was elaborately analyzed in the previous section, Silicon Valley futurist Paul Saffo remarked: "Human time is not an arrow, nor is it a river. It is a tapestry, a tangled braid of culture, events, artifacts, history, and, above all, memory. *A Chain of Events* captures its infinite, messy interrelationship perfectly. It is a self-weaving quipu of humanity's time on the planet and a reminder that, as John Muir once observed, 'everything is hitched to everything else.' Observing the artifacts tangled up in this braid of time, one is reminded that everything emerges from something else - everything comes from a coincidence of earlier events and artifacts. Silicon Valley worships the myth of the solitary innovator creating something from nothing. *A Chain of Events* is a visual reminder that innovation is something very different, a process of bricolage. Like a child examining shells on some far beach, innovators are bricoleurs sitting among the tangle of innovative wreckage, reaching out for shiny bits that catch their attention, contemplating the novelties made possible by their recombinations. And, of course, the reward for the successful innovator/ bricoleur is that their novelty will also be woven into the braid, becoming, in turn, a piece of marvelous rubble that, one day, another innovator will recombine into some astonishing new thing."

This is precisely how I see myself, as a bricoleur who continues to add new knots in the endless chain of evolution, hoping they might help someone in the future to create something new again. Within a retrospective solo exhibition, I can show precisely that: a series of knots (or works) forming a string of thoughts or a chain of interlinked events that form a complex narrative.

On the occasion of this first retrospective exhibition, I also had the opportunity to produce three new works that are all part of my Ph.D. research, but due to space limitations, I can only show two of them in my final presentation at Høyersten Contemporary in Bergen, Norway. The first work, *A Chain of Events,* is by far the largest and most complex, central to the exhibition and my reflection. The second work, *The Points of No Return,* is shown in a reduced size, compared to the first time I showed the work, because of the

particular but very suitable space for the work in Høyersten Contemporary, a narrow corridor in the back room behind a newly constructed wall.
In Mu.ZEE, the work was located at the end of the exhibition, although the purple UV light was already visible halfway through. It created a kind of *encore*, or final gift from humankind (and me), not yet accessible (because the stairs were closed off) but already visible as a future promise. *The Points of No Return* is made of melted uranium glass shaped like stalactites that become fluorescent green when exposed to UV light. The title references the alternative time

Maarten Vanden Eynde, *The Points of No Return* (detail), 2021, Mu.ZEE, Ostend, Belgium (photo: Mathew Lau)

The Points of No Return (detail), 2021, Høyersten Contemporary, Bergen, Norway (photo: Maarten Vanden Eynde, 2024)

Maarten Vanden Eynde, *The Points of No Return,* 2021, Mu.ZEE, Ostend, Belgium (photo: Steven Decroos)

scale Before Present or BP[25] (sometimes mentioned as Before Physics), which is also used throughout this text. Year 0 is 1950 in the BP time scale, and it is instigated by the artificial alteration of the proportion of carbon isotopes in the atmosphere by nuclear weapons testing, making carbon dating after that time increasingly challenging. There is no way back.

Geologist Jan Zalasiewicz said about the work: "There is a kind of stratum that geologists like to stumble across as they walk the hills. It is called an event stratum and has a beautiful simplicity, as each tells of a single happening. Some reflect the most banal occurrence, such as a sudden rain shower imprinting splash-marks onto some prehistoric mudflat. Others are more dramatic, such as an ash layer spread continent-wide by a volcanic super-eruption. Most iconic of all is the worldwide layer rich in iridium and frozen rock-melt droplets from the giant meteorite impact that ended the Cretaceous Era 66 million years ago. Now, this list has been expanded by trinitite from the Alamogordo nuclear test site (and its Soviet counterpart, Kharitonchik, from the Semipalatinsk testing grounds). Made of desert sands flash-melted by a nuclear blast, it brought, like the Cretaceous meteorite, wider changes—among them, perturbation of Earth's radiocarbon balance and of the scientific dating based on this. Will it bring, too, the final traces of human presence on Earth? Only time will tell."

The work's affect is a Bennettian "enchantment," or "that strange combination of delight and disturbance" (Bennett, 2010). It is both daunting and scary but also festive and nightclub-like: a final party, a last toxic dance before the lights go out…

[25] BP is mainly used in archaeology and geology and increasingly in other sciences that want to abandon the baseline denotation of a year 0 referencing a particular religious figure (AD = anno Domini, BC = Before Christ, or BCE = Before Common Era) as is used in Julian and Gregorian calendars.

Maarten Vanden Eynde, *Check Mate,* 2020 - ongoing, Mu.ZEE, Ostend, Belgium (photo: Steven Decroos)

The third work I was able to produce is *Check Mate,* a growing installation that is currently too big to include in the final presentation because it measures 6 x 6 meters. The work is included in the reflection with documentation from the first exhibition in Mu.ZEE and the last exhibition, shown in Sainsbury Centre in Norwich, UK, which closed in January 2024.

According to legend, a courtier invented the chess game for a king around 1,300 BP. So delighted was the king by the game that he swore to reward its inventor with whatever he asked for. “Just put one grain of rice on the first square, two on the second, four on the third, eight on the fourth, and go on doubling like that till the last square is reached,” came the answer. The king laughed at this seemingly modest request and ordered it to be fulfilled. But his laughter soon turned to lamentation as it became clear that not all the rice in his kingdom or even the whole world would fill so much as half the board. Thus, the potential peril of exponential growth. Each time *Check Mate* is exhibited, the chessboard is enlarged as a new square is filled with an exponentially increasing number of plastic pellets: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024 (and so on). The work visualizes the scale of the problem of plastic pollution – over 300 million tons are produced annually – and simultaneously amplifies worldwide efforts to raise awareness and find solutions to this complex and multilayered global threat.

Also known under the more poetic and tragic name *mermaid tears*, nurdles are released into the environment, creating unprecedented pollution in the oceans and on beaches worldwide. Currently, nurdles cannot be recycled in general recycling. These plastic pieces are the raw material of nearly all our plastic products, which means they are often made of different types of plastic.

Maarten Vanden Eynde, *Check Mate* (detail), 2020 - ongoing, Mu.ZEE, Ostend, Belgium (photo: Mathew Lau)

Check Mate is a growing installation, a huge chessboard that is gradually filled exponentially with plastic nurdles that are collected around the world by a growing team of volunteers and organizations that hand pick the nurdles during seasonal beach cleanings or after huge nurdle spills that take place regularly, like the most recent one near Sri Lanka where several containers went overboard and created mountains of highly toxic nurdles on the beaches close to the disaster. The amount of available and collected nurdles prior to the exhibition determines the size of the chessboard, as the last pile needs to spill over the margins of the last used square.
During the exhibition of the work, depending on the duration and available budget, an additional effort is made by engaging local and international participants to fill one more square[26].

[26] One of the most important partners is Fidra, an environmental charity from the UK, which organizes the annual Great Global Nurdle Hunts and encourages participants to donate their finds for art after they count them.

Maarten Vanden Eynde, *Check Mate,* 2020 - ongoing, Sainsbury Centre, Norwich, UK (photo: Sainsbury Centre)

For the exhibition at Sainsbury Centre[27], we arrived at the fourth square of the third row, which has a staggering amount of 524,288 individual nurdles piled up, bringing the total amount on the entire board to 1,048,575 nurdles.

At some point in the distant future, I hope to arrive at what is notoriously known in technology strategy as "the second half of the chessboard." Coined by Ray Kurzweil, it represents the point where an exponentially growing factor (often used in relation to ecological disruptions due to climate change) begins to have a significant economic impact on an organization's overall business strategy, no matter what it does or produces (Kurzweil, 1999). While the number of grains on the first half of the chessboard is large, the amount on the second half is vastly (232 > 4 billion times) larger and will never be reached.

Around the same time, I made *1001 Mermaid Tears*, a huge snow globe or magic crystal ball filled with 1,001 plastic pellets. These virgin plastics or nurdles are nicknamed *mermaid tears* because roughly 1,400 billion are spilled yearly during transport (for crying out loud). They are the first form of everything made of plastic, the primordial eggs out of which all our plastic consumer goods hatch. Coming straight from the petrochemical plant that produced them, they end up in the world's oceans before even being used once.

The fairytale of plastic throwaway products, marketed as the savior of humanity in the middle of the 20th century, turned into a never-ending nightmare. Plastic debris is now the most common surface feature in all the oceans worldwide, and not a single beach is plastic pollution-free.

[27] The exhibition was called *The Stuff of Life / The Life of Stuff* and was curated by Vanessa Tothill.

Maarten Vanden Eynde, *1001 Mermaid Tears*, 2022 (photo: Philippe De Gobert)

1001 Mermaid Tears is a sarcastic reference to the predicted future and a beautiful and telling souvenir of the past. Shaking this time capsule for the future creates a micro gyre in the water and makes the plastic swirl around, but contrary to an actual snow globe, the particles don't fall but float on the surface when the water calms down.

The second retrospective exhibition, *Exhumer le futur* (*Digging up the Future* in French), took place in La Kunsthalle Mulhouse in Mulhouse, France, in 2022 and was co-curated by Katerina Gregos and Sandrine Wymann, the director of La Kunsthalle. Next to 12 works that were also shown in Mu.ZEE, an additional 14 works were added that were previously not included. For all of them, a new analytical text was written for the audioguide[28].

For the exhibition at La Kunsthalle, I was able to produce one new work, *Fat Man 3D,* exhibited in the entrance hall of KMD in Bergen, Norway, as part of my final presentation.

[28] Next to Naima Charkaoui, Marjan Doom, Jean Katambayi Mukendi, Paul Saffo, and Jan Zalasiewicz, whom we asked to write about one or two new works, we also invited Catherine Roth (Associate Professor in Cultural Studies and Media Sciences at the University of Haute Alsace), Florence Fröhlig (ethnologist at Södertörn University, Sweden), Tatiana Kapersky (author and historian of science, technology and environment at Universitat Pompeu Fabra, Spain), and Frederic Ruch (plastics expert for the Cetim Grand Est, France) to contribute.

Maarten Vanden Eynde, *Fat Man 3D*, 2022, La Kunsthalle Mulhouse, France (photo: Maarten Vanden Eynde)

Fat Man 3D is a copy of the atomic bomb, code name Fat Man, that was dropped on Nagasaki, Japan, on 9 August 1945. The work laces together the interlinked histories of cotton and uranium in an immersive and explosive installation. Most of the uranium used in the first atom bombs produced in the framework of the Manhattan Project came from the Shinkolobwe mine in Katanga, in what was then the Belgian Congo. It was processed in America's southern states and shipped to Antwerp in Belgium by the Belgian businessman Edgar Sengier, the director of the Union Minière du Haute-Katanga, an Anglo-Belgian mining company operating in the Congo's copper belt between 1906 and 1966. A similar route was followed in the past by cotton. Enslaved people transported from the Kingdom of Kongo in central Africa and elsewhere planted and picked cotton in America's southern states, whence it was shipped to the cotton mills of the United Kingdom and also to Belgium and the rest of western Europe to be used in the bobbin lace industry. That is not the only tragic link between the braided histories of cotton and uranium. When the Second World War broke out, Japan was one of the world's major cotton producers and traders, almost surpassing Britain. Dropping Little Boy and Fat Man (the code names of the second and third atomic bombs made by the US as part of the same Manhattan Project) on Hiroshima and Nagasaki heralded a definite end to the cotton empire of Japan.

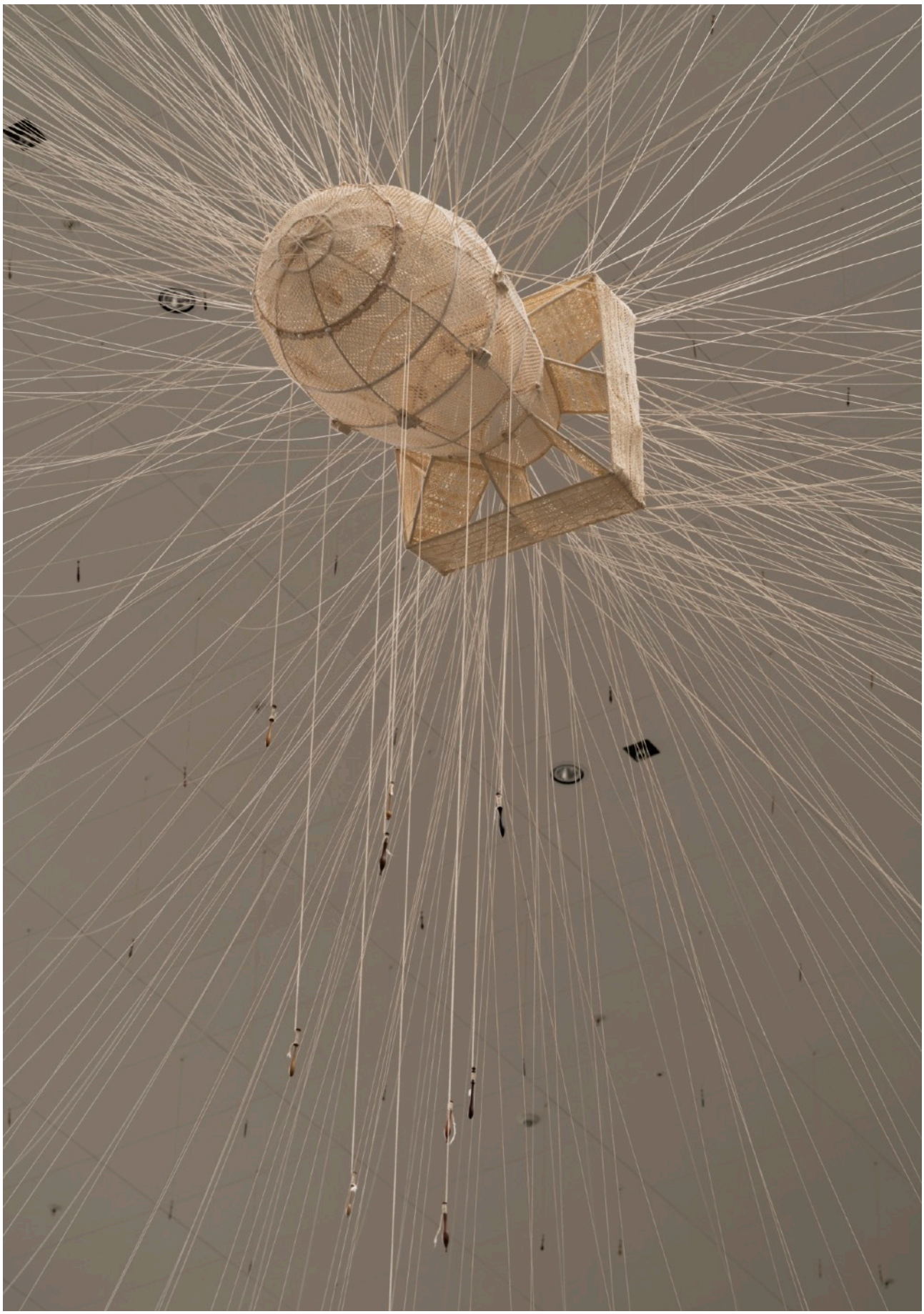
Ethnologist Florence Fröhlig and historian of science, technology, and the environment Tatiana Kaspersky wrote: "By lending visibility to all the different people and institutions involved, directly or indirectly, consciously or unconsciously, *Fat Man 3D* reminds us that the production of the bomb was the result of a collective venture. From one stage of the process to the next, so many lives were dedicated to carrying out this work, whether in the extraction of uranium to the production of plutonium, the decisions made in ministers' cabinets and army headquarters, or the

Maarten Vanden Eynde, *Fat Man 3D*, 2022, KMD, Bergen, Norway, France (photo: Maarten Vanden Eynde, 2024)

development and assembly of the bomb in scientific laboratories. The spindles, still attached to the spools of thread, are intertwined in a crazy plot to develop a machine with which to destroy human lives. Is our collective responsibility sewn with white thread? Since the creation of nuclear weapons, life – our life, dependent on other lives – has been hanging by a thread. Will we be able to learn from the destruction of the past to preserve the fragile fabric of our intertwined lives?"

In La Kunsthalle Mulhouse, *Fat Man 3D* was the first work the visitor encountered, and while walking up the stairs towards the rest of the exhibition, the work could be experienced from different heights and perspectives. For the final presentation of my Ph.D., the work is shown in one of the few spaces in Bergen that can host this complex work: the huge entrance hall of KMD. The work is a singular example of the complex creation process involving different people and different stages of research, as discussed in the previous section about art-making. Although the very labor-intensive installation was mainly produced with the help of Rita Van Cotthem, an expert in 3D bobbin lace art, the whole process, from start to finish, looks rather like a "collective venture," as mentioned by Fröhlig and Kaspersky. It is a scaffolding process, not just because of the installation requirements for the work itself or because of the multiple steps (by multiple people) that need to be taken to be able to realize it, but because of the necessary deconstruction and reconstruction of the historical references to a specific series of events that need to have taken place for the work to exist. As an artist, I walk the entangled ropes of history that help me navigate and support my thinking. At the same time, these pre-existing spiderwebs lure and inspire me to add new treads and make certain connections stronger or (a)new.

Art making and exhibition-making are thus, for me, much more a collective practice, a Latourian "composition" of sorts (Latour, 2010), a means to simultaneously *de*-compose artificial ruptures in the fabric of history and *re*-compose different prospects of the past in order to imagine alternative futures.



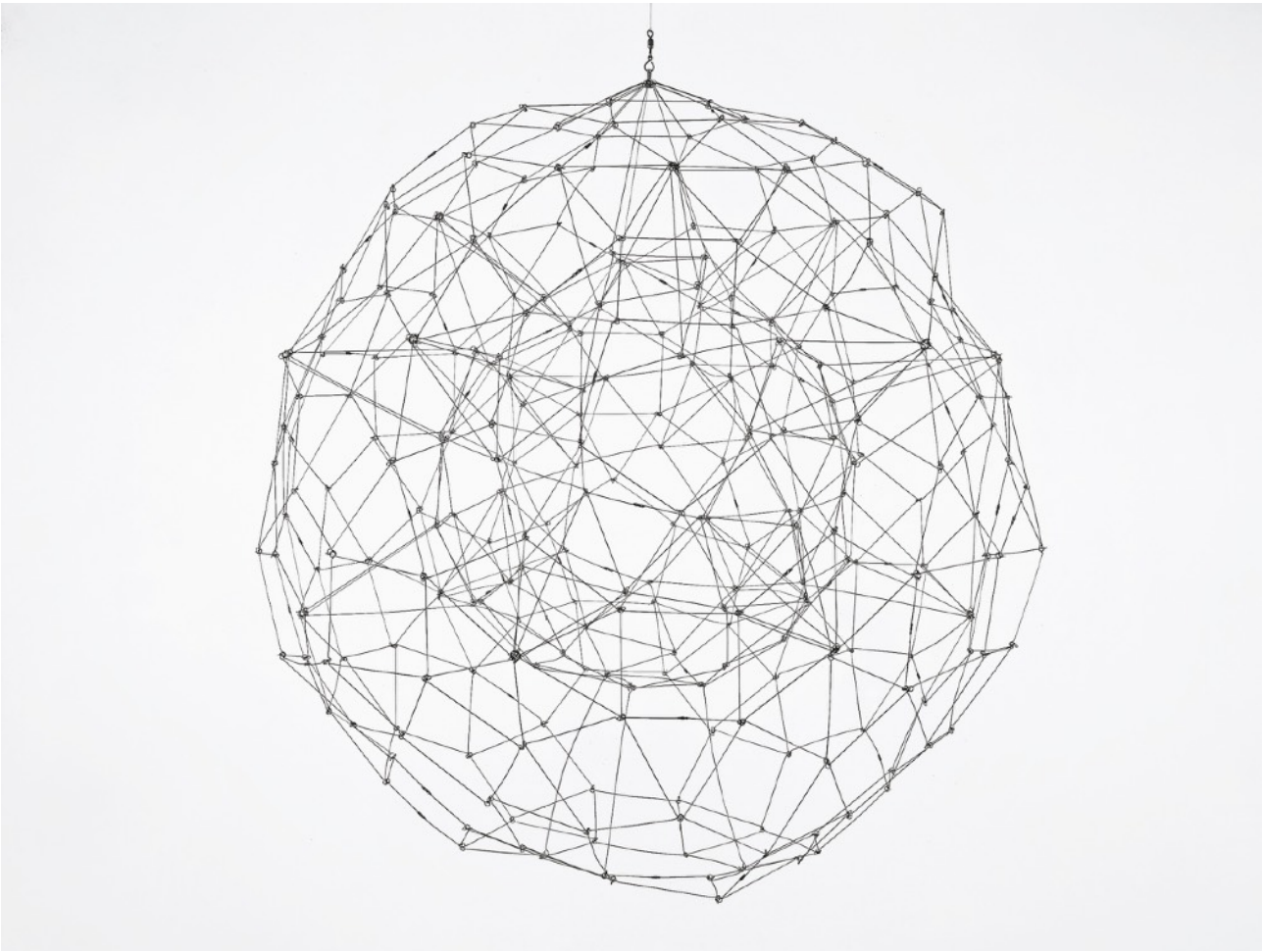
Maarten Vanden Eynde, *Fat Man 3D*, 2022, KMD, Bergen, Norway (photo: Bjarte Bjørkum, 2024)

Tomas Saraceno, *Galaxies Forming along Filaments, like Droplets along the Strands of a Spider's Web,* 2008 at Tanya Bonakdar Gallery, New York (Photo: Fabian Bergfield).

In 2008, the Argentinian artist Tomas Saraceno made the beautiful immersive installation *Galaxies Forming along Filaments, like Droplets along the Strands of a Spider's Web*, which was shown a year later in a different constellation at the Venice Biennale. The work has a similar visual explosive force as *Fat Man 3D* while dealing with micro and macro perspectives of cosmological phenomena and down-to-earth spider logic. His ability to weave together imagery from spiderwebs, neural networks, and the dodecahedron galaxy is awe-inspiring. The materials used to construct the work, synthetic black elastic ropes, don't seem to play an important part in the narrative and are more functional than conceptual, quite similar to Gego's[29] spacial drawings for which she uses many different materials, like steel wire, nylon cords, and metal pipettes. Besides being recycled and old, which was a critique of the prevailing utopian ideas of Modernism at the time, she never drew the connections of the specific material properties in a more material-historical sense. Gego mainly used various materials to create lines, kinetic sculptures, and room-filling installations meant to generate the feeling of movement through optical illusions and play with the visual angle of the viewer while moving through the space.

I saw Gogo's refined work in the Fogg Museum while researching at Harvard Museums in 2022. Some of the *Drawings without Paper* made with metal wires, especially the ones with abstract geometrical shapes, look very similar to the *Wapete* or Marshall Islands stick charts used to navigate between the Polynesian islands and the string figures mentioned in the second chapter. More recently, other artists have made enlarged versions of similar stick charts, like Taloi Havini

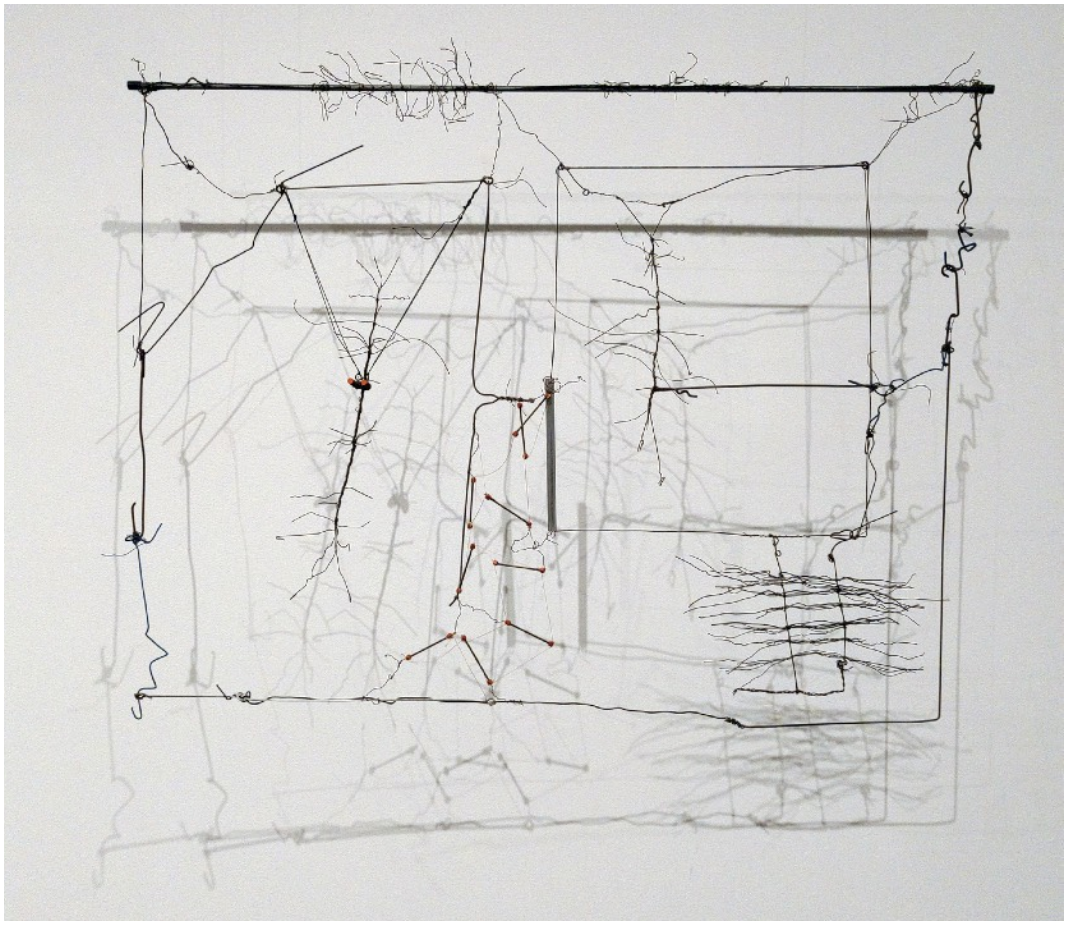
[29] Artist name of German-Venezuelan artist Gertrud Goldschmidt who is particularly known for her geometrical sculptures from the 1960s and 1970s, which she called 'drawings without paper.'



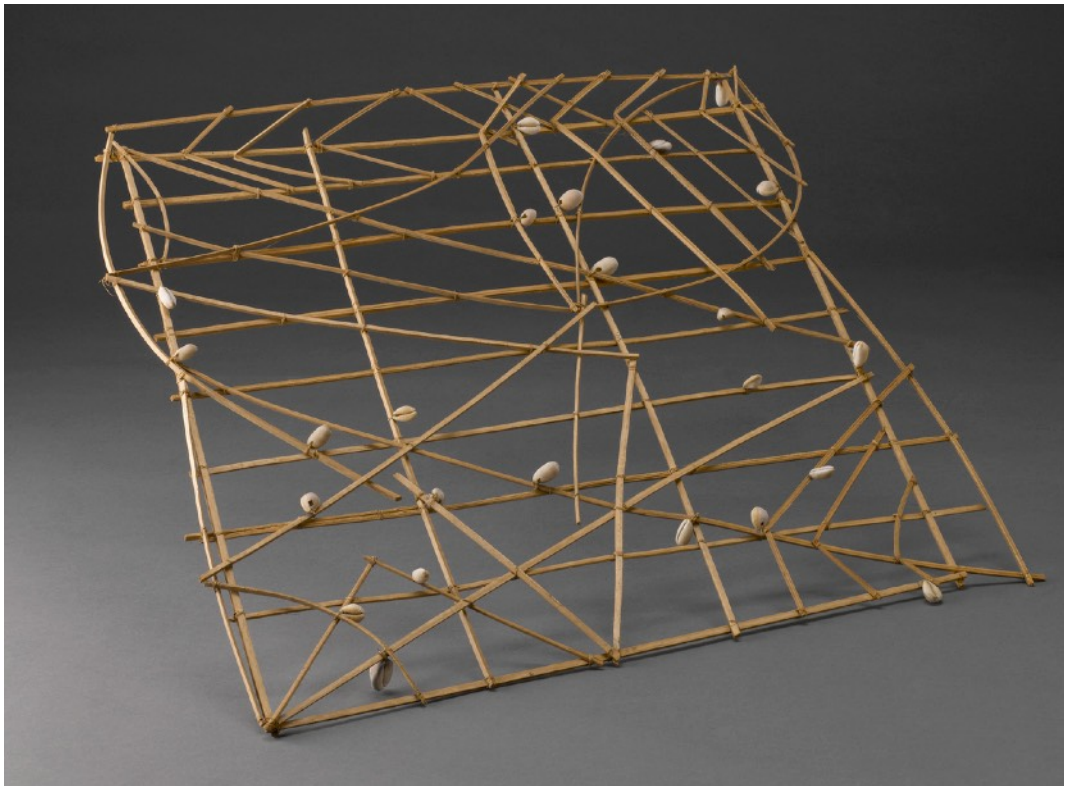
Gego (Gertrud Goldschmidt), *Esfera no 4 (Sphere No. 4)*, 1976. Steel and copper. The Ella Fontanals-Cisneros Collection, Miami. © Fundación Gego. (Photo: Oriol Tarridas, courtesy CIFO Cisneros Fontanals Art Foundation).

for her *Reclamation* series and the young German artist Markus Hoffmann in a series of works named after what they are: *Stick Charts*. Although I appreciate the formal qualities of the mentioned works, I miss the historical and Larourian *de*-composition and *re*-composition of the narrative of the used materials, something I deem necessarily interconnected to the choices of matter.

For the series of works called *Tenerife Tech,* I combined the early computer technology of weaving ferrite rings with copper wires to create magnetic-core memory and the lace-making technique called Tenerife, which involves stitching and knitting threads usually in the shape of a circle, giving it the name of *Spider Lace*, or *Sun Lace*. The origin of this knitting technique remains unknown, but it appeared for the first time in European paintings from the 16th century. The Spanish spread it during their colonial expansion, including the Canary Islands, giving it its current name: *roseta Canaria,* or *roseta de Tenerife*. It was traditionally made with silk or cotton, but when the Belgian Sisters of Charity of Jesus and Mary from Ghent arrived in the late 19th century in what was then known as Congo Free State (now D.R. Congo), they forced children to copy Tenerife lace in local materials like raffia and tree bark. They learned the Tenerife technique on the Canary Islands, a regular stop from Antwerp in Belgium to Matadi in the Congo Free State, and introduced it in the early mission schools. It was initially presented as a form of *civilizational reform* to turn young Congolese girls into morally well-behaved Catholic housewives until it grew into a massive industry for tourist souvenirs (Van Beurden, 2020).



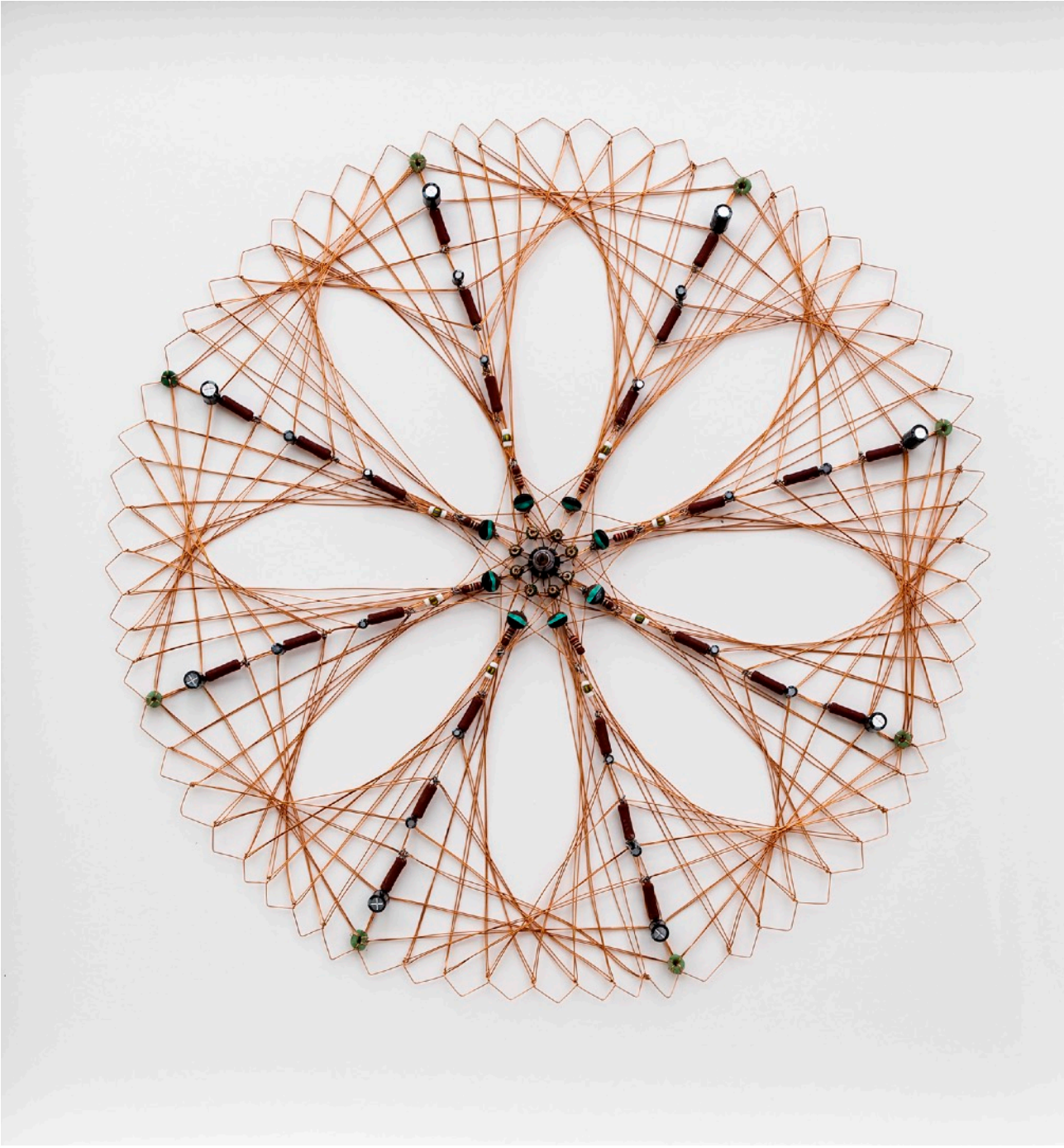
Gego (Gertrud Goldschmidt), Dibujo sin Papel 85/1 (Drawing without Paper 85/1), 1985.
Fogg Museum, Cambridge, US (photo: Maarten Vanden Eynde, 2022)



Wapete, or Marshall Islands stick chart © Science Museum/Science & Society Picture Library

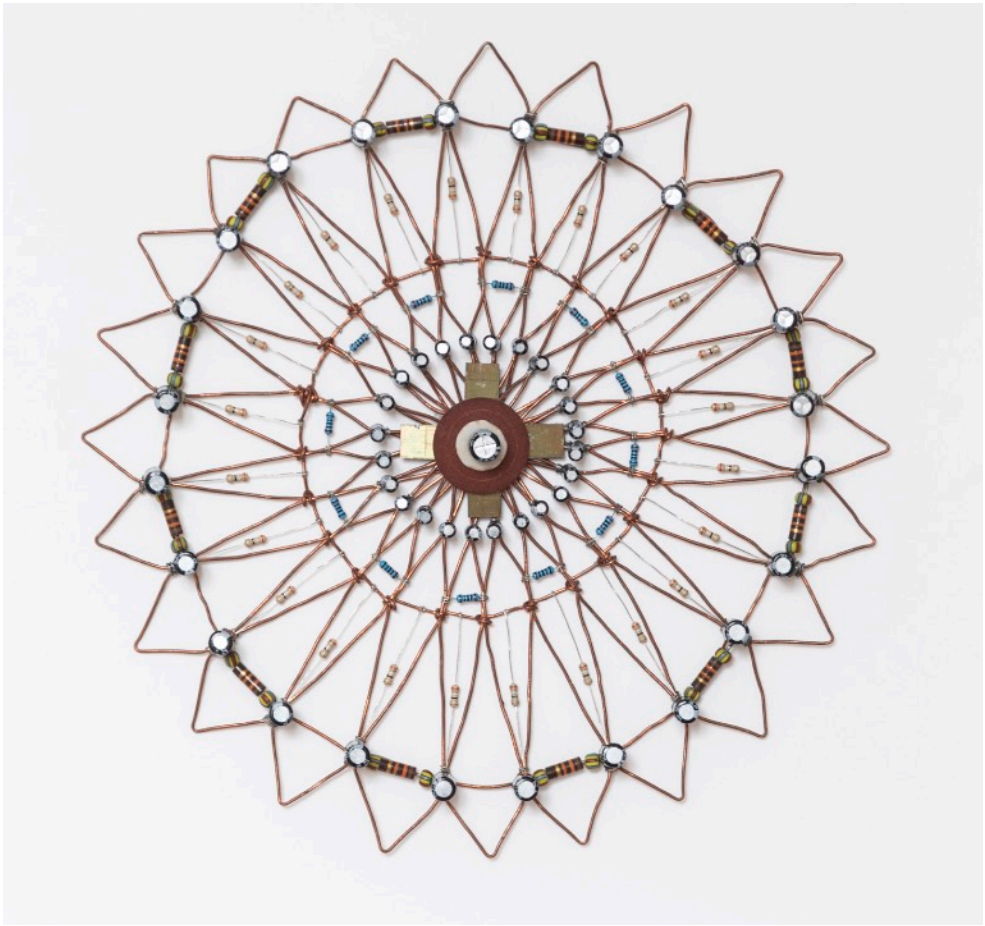
Tenerife Tech is made with copper wires to connect with the copper circuits or veins that are part of every electronic device and with D.R. Congo, the largest copper producer in the world, for a long time during Belgian colonization in the 20th century.

It is laced with ferrite rings, resistors, capacitors, silicon microchips, and trade beads to reconnect with the colonial legacy of lace-making but also the historical importance of binary code invention in Africa and the role it played in the externalization process of memory throughout human history.



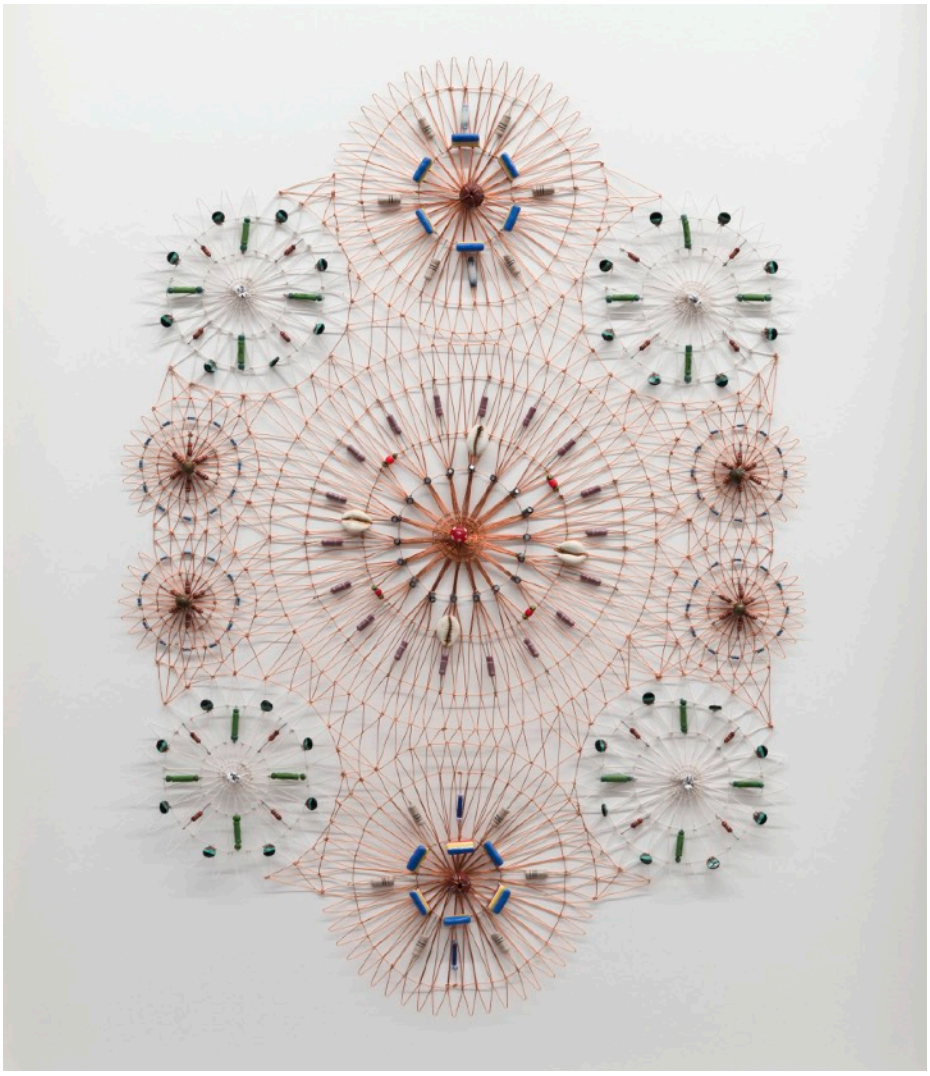
Maarten Vanden Eynde, *Tenerife Tech III*, 2023 (photo: Alice Pallot)

Young girls making Tenerife lace. Image archive of Franciscanessen-Missionarissen van Maria (FMM), glass negative Sondoa.14. © KADOC



Maarten Vanden Eynde, *Tenerife Tech I*, 2023 (photo: Philippe De Gobert)

Overview of *The Art to Remember,* Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum, 2024)



Maarten Vanden Eynde, *Tenerife Tech IV*, 2024, Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum)

Maarten Vanden Eynde, *The Origin of Objects*, 2023. Commissioned by IJssel biennial (photo: Maarten Vanden Eynde).

History in the Making

The last retrospective exhibition, *Gravend naar de Toekomst* (*Digging up the Future* in Dutch), occurred in 2023 in Museum EICAS (European Institute for Contemporary Art and Science) in Deventer, The Netherlands. The exhibition was co-curated by Fred Wagemans and Caroline Daams. However, I was responsible for the entire scenography, which helped me prepare for the final presentation at Høyersten Contemporary in Bergen. Next to 12 works featured in one of the previous iterations of the retrospective solo exhibition, 13 new works were included that had previously not been presented. A total of 7 works were made as part of my PhD project and are shown in my final presentation.

Walking through the exhibition became a remembering experience, a physical memory palace, where works from the past 20 years created dialogues with each other that were perceivable by the visiting audience by following the mental or visual breadcrumbs I left behind. The whole exhibition was turned into a kind of chain of events.

Simultaneously, I participated in the IJssel biennial, which took place along the IJssel river, which also passes through Deventer and is close to Museum EICAS. I produced another big installation that accompanied the retrospective exhibition with existing works. The installation *The Origin of Objects* consists of a series of concrete boulders ranging in size from one to two meters in diameter in which a hollow space is visible. Mirroring the empty spaces found in the lava at Pompeï, the voids each represent a specific object whose role and function were vital or symbolic for the evolution of mankind. They include the wheel, a sewing machine, a 35mm film camera, the first Apple computer, and a Nokia 3310. A mother mold is made of every object, suggesting perfect archetypes, of which objects in the everyday world are imperfect copies, referencing Plato.

Maarten Vanden Eynde, *The Origin of Objects*, 2023, Sculptura #2, Brussels, BE (photo: Ingrid Geboors)

The molds, like cut-open giant geodes, are made of recycled concrete and show only the negative form of every object, revealing the contours of what once was. Together, they form a cluster of remnants of human presence and influence on Earth to be discovered in a fictional future. During my final presentation in Bergen, and until the end of 2024, the work will be exhibited in Sculpture #2, a major European sculpture exhibition in Tour & Taxis in Brussels, Belgium, as a part of the Belgium Presidency of the Council of the EU.

Chihuahua Footprints Discovered!

In 2018, a wolf was spotted in Belgium again for the first time in over a century when She-wolf Naya crossed the Dutch border into the Belgian province of Limburg. Since then, the wolf has not disappeared from the news, and its presence continues to stir the imagination. We now know that the wolf was the first wild mammal to approach humans and was slowly domesticated into the dog that is now, for many, man's most loyal friend. The range of varieties is almost inexhaustible through cross-breeding and breeding programs, of which the chihuahua is the most extraordinary result and the furthest removed from its original ancestor, the wolf.
It has become a familiar status symbol to a host of Hollywood stars, from Britney Spears, Madonna, Mickey Rourke, Marilyn Monroe, Reese Witherspoon, The Rock Dwayne Johnson, Scarlett Johansson, Demi Moore to Paris Hilton, whose chihuahua named 'Tinkerbell' was by far the most famous, wearing clothes from Dior and Louis Vuitton and owning a $325,000 doghouse. *Chihuahua Footprints Discovered!* was an intervention in the collection of the Gallo-Roman museum in Tongeren, Belgium, and includes both a stuffed Chihuahua attached to one of the custom-made dolls that represent prehistoric people and a slab of concrete in which the same dog left some distinct footprints.

Maarten Vanden Eynde, *Chihuahua Footprints Discovered!*, 2021 (photo: Gallo-Romeins Museum)

Maarten Vanden Eynde, *Chihuahua Footprints Discovered!*, 2021 (photo: Gallo-Romeins Museum)

For my mid-way presentation and the third retrospective exhibition, the work was taken out of the in-situ context and presented in front of *Taxonomic Trophies*. This ongoing work consists of a growing collection of tree branches from all over the world, saved and presented as endangered or extinct species. They have been hunted and gathered during work periods, residencies, exhibitions, or holidays abroad since 2005. They question values and status symbols of power and financial means while confirming our insatiable desire to accumulate and collect. An iteration of *Taxonomic Trophies* is also exhibited for my final presentation, showcasing only trophies collected during my Ph.D. research period.

Hunting and gathering is one of man's most fundamental activities. Initially a nomadic survival strategy, hunting became a sport or amusement as humans settled in one spot and domesticated plants and animals. The trophies from a successful kill were a way of impressing other people. In rarer cases, hunting was organized for scientific purposes, to preserve a particular endangered species, or to prevent the spread of alien invasive species.

Both works relate more to the previous archaeological focus in the initial proposal, *Digging up the Future*, and are shown as a cabinet of curiosities in the final presentation at Høyersten Contemporary.

Maarten Vanden Eynde, *Chihuahua Footprints Discovered!*, 2021 and *Taxonomic Trophies*, 2020-2024, Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum)

The last presentation I want to discuss is my participation in the first GIST triennial in 2023, which took place along the River Senne in Belgium. I presented four works at FelixArt Museum, one of the main venues, all focusing on energy production, transition, and storage. I also created one new work, *The Gordian Knot*, which was presented in my final presentation together with *What All The World Desires*.

The Gordian Knot consists of an inextricable knot of colorful insulators firmly connected with thick copper rods and cables. Massive electricity cables and pipes, as well as natural lianas and other cables and ropes, create a sizeable spherical knot that is impossible to take apart. The work symbolizes the complex story of energy generation, transmission, and storage in the context of a green fossil fuel-free future while at the same time referencing Schopenhauers *Weltknotten*, or "world-knot," a metaphor he used to describe the *mind-body* problem (Schopenhauer, 1859).

The experience, or affect, of *The Gordian Knot* is physical rather than theoretical, and contrary to British artist Elizabeth Price's work *Boulder*, a massive ball made out of packing tape, which is an ongoing work she started in 1996, it has no *Sidekick* or descriptive text as a supplement. *Sidekick* is the accompanying text that, together with *Boulder*, comprised Price's successfully submitted artistic Ph.D. project of 2000, which "annotates the incremental progression of a labor-intensive activity" (Price, 2002). It is an extreme example of research *through* art, where, in this case, the reflection on the making process is clearly taking overhand, leaving the viewer behind with a gigantic shiny ball of wrapping tape when the *Sidekick* text is not present. Although a whole debate is included in the reflection about the possibility of the ball being empty (or not entirely full), and the artist thus pretending to have done all the labor of rolling the ball endlessly to increase its size at a declining pace because of the growing size, it does not seem to add much aesthetic or other symbolic weight to the work itself.

Maarten Vanden Eynde, *The Gordian Knot*, 2023, Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum)

Maarten Vanden Eynde, *The Gordian Knot*, 2023, Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum)

In 2013, the American visual artist Mary Mattingly created an almost mirrored boulder called *Pull,* consisting of nearly all her worldly possessions bound together with rope into a gigantic sphere. She then added physical and symbolic weight to it by pulling the boulder through the streets of New York, resembling a contemporary female Sisyphus. Like with Price's boulder, we don't know if Mattingly's boulder is full or if she added all her possessions (no bed, table, and chairs?), but that's beside the point. The power is, first of all, condensed in the image itself and secondary in the viewer's imagination. How much do the boulders weigh? Is it even possible to roll them? What is hidden inside? Visually, Mattingly created a much more powerful image. Still, Elizabeth Price's boulder intellectually instigated a much more influential debate about artistic research (because it was part of her doctoral degree) and the relevance of doing a practice-based or studio Ph.D.

It raises the question of to what extent there is a difference between engaging in a philosophical discourse or, more specifically, in anthropological discourse (Ingold, 2013) about making art instead of actually *making* art.

Maybe there is no *art-theory* problem, as much as there is no *mind-body* problem (Clark & Chalmers, 1998; Paul, 2021) or *nature-culture* problem (Haraway, 2003). Isn't art a form of theory and vice versa, or as Borgdorff proposed, isn't theory a form of practice (Borgdorff, 2021)? Is this what Agnes Denes called *Visual Philosophy* (Denes, 1986)? Art making and exhibiting are different forms of communication and thus can, in line with Haraway's *natureculture,* be understood as *artheory* (in this case, with one t instead of two tts), offering a nearly homophonean artery for the art-theory divide; in artistic research, they are each other's lifeblood and oxygen.

Mary Mattingly, *Pull,* 2013 © the artist and Robert Mann Gallery

The Art of Curating

In Paris, I also started working as a co-curator with Oulimata Gueye on the group exhibition *Ars Memoriae*, which took place in 601Artspace in New York, US in 2022. It was a fantastic experience to work on the curatorial framework together and learn from the other artistic approaches toward memory in relation to the history of technology. On top of being extremely knowledgeable about the particular research field relating to the role of digital technology on the African continent, a field she partly established, Oulimata Gueye is a researcher and curator from the heart. She taught me that understanding interrelations in media archaeology and how artists research and work within, about, or through that subject matter is as much an accumulation of data and knowledge as externalization and sharing of emotions. Although it was artist Heidi Gustafson who pointed me toward the notion of the archaeology of the heart during my final presentation in November 2023, referencing the book with a similar title, *Archaeologies of the Heart* (Supernant, Baxter, Lyons, Atalay, 2020), it was Oulimata who let me feel it. I had never worked with such a sensitive, thoughtful, and empathic curator before, and having experienced firsthand what it does to and for the participating artists (me included), I hope some of her *heart* work rubbed off on me.

One of the artists that me and Oulimata selected was Nigerian American visual artist Mimi Ọnụọha. She reveals the harsh effects of "algorithmic violence," in Oulimata's words, that is inflicted on minorities through under-representation and misrepresentation in datasets that are used in the making of civic, social, and cultural policy. Her work, *The Library of Missing Datasets 2.0,* consists of a filing cabinet full of folders with ominous labels like "Number of queer residents in Sudan," "How much US culture came from Black culture," "Number of Black women who served in the Vietnam war" or "Craft skills held by 19th century enslaved folks in New Orleans," that are all empty. It's the horror vacui of an erased black box containing no more data, a rope without knots. Ọnụọha's box is warm gold, however, and stands on a stage in the middle of the room. It occupies a central place in the exhibition, turning its embedded visual voids, its *Missing Datasets,* into meta-presences or even Mortonian *Hyperobjects* (Morton, 2013). Their absence becomes their undeniable presence. The work is made of a cold metal drawer, generic office equipment, language, and imagery, but it doesn't feel dead or empty. It feels very much alive, full of voices of warm-blooded ghosts, people without names or numbers, but with an indisputable and influential presence and power once they are exposed and made visible.

In the back of the room, *The Subterranean Imprint Archive* by South African artists Francois Knoetze & Amy-Louise Wilson (Lo-Def Film Factory), in collaboration with Congolese researcher Joe-Yves Salankang Sa-Ngol, is exposing a very different hidden truth: the material and mineral dependency of digital technology. A gigantic rhizome of wires and electronic components is dripping and draping down from the ceiling and the walls, creating a cave-like decor in which the visitor can experience firsthand the entangled visual reality behind virtual reality and digital technology in general. A dangling VR headset invites people to pull the curtain of *raw material independent* virtual reality and takes them on a journey through the rabbit hole of AI in Wonderland. Also, the missing masses, from extracted matter to forced labor and e-waste dumpsites, are overtly present here. They scream in their forced silence.

Oulimata Gueye and I worked on an exhibition that exposed different artistic approaches towards the invisible forces of absence. From Jean Katambayi Mukendi's *Afrolampes* series, which highlights the absurd discrepancy

Ars Memoria exhibition in 601Artspace, NY, 2022. From left to right: MaartenVanden Eynde, Analia Saban, Mimi Onuhoa, Lo-Def Film Factory (Francois Knoetze & Amy-LouiseWilson) + Joe-Yves Salankang Sa-Ngol (photo: Maarten Vanden Eynde).

The Subterranean Imprint Archive, 2021, by Lo-Def Film Factory (Francois Knoetze & Amy-Louise Wilson) + Joe-Yves Salankang Sa-Ngol (photo: Maarten Vanden Eynde).

between Congo's role as a supplier of so many raw materials for technological devices while at the same time missing even the most basic electrical grid, to Marjolijn Dijkman's *Earthing Discharge* series which enlightens not only the obscured visual properties of electricity through the use of a particular technique to create a corona discharge, but also its semantic and scientific roots dating back to the Enlightenment period itself. From Suzanne Treister's drawings from *HFT The Gardener,* which introduced the hallucinatory powers of algorithms before AI proved her right (resulting in the Guardian nominating 'hallucination' as the breakthrough word of 2023), to Analia Saban's *Motherboard #8,* a blown-up circuit board becoming a musical score, all the works in the exhibition are strongly stratified and reveal multiple and complex perspectives on holistic technological realities.

Together, we wrote the following curatorial statement: 'At the turn of the 21st century, human civilization is shaped by machines, networks, data, artificial intelligence, financial speculation, digital traceability, and the commercial exploitation of our behavior. *Ars Memoriae* brings together ten artists[30] from four continents who take inspiration from technology while simultaneously questioning the mainstream history of digital technological progress, offering alternative visions and new connections, and speculating on the future implications of living in a technologically augmented reality.

An important exhibition aim is to recenter the African continent within the larger historical record of technological innovations. In the mainstream narrative of digital technologies, Africa has been reduced to supplying raw materials for the technological revolution elsewhere; *Ars Memoriae* challenges this limited view. Tabita Rezaire's work echoes current research that shows that computer science originated in African divination systems. Through a fantasized smart-phone conversation, Rezaire's *Sorry For Real _Sorrow For _Land* (from her more extensive series *Sorry For Real*) questions the power imbalances within the apology-forgiveness narrative and seeks to virtually capture the violent histories of slavery, colonialism, and the continued exploitation of African and Indigenous bodies, lands and knowledge. Together with Congolese researcher Joe-Yves Salankang Sa-Ngol, the South African collective Lo-Def Film Factory engages with central and southern African archives to unearth contested histories of mineral extraction, uneven distribution, and e-waste. The result is *The Subterranean Imprint Archive*, which examines Africa's role in developing the first atomic bombs through the Shinkolobwe mine in the former Belgian Congo, the source of the uranium used for its development.

Ars Memoriae brings together a diverse selection of artworks, each addressing memory uniquely within the framework of the history and archaeology of media. By analyzing different layers of subsequent technological inventions, much like geological strata, the works in this exhibition elucidate new relations and previously obscured correlations that tell a new story about how we got here. The artists draw a critical and alternative cartography of new media history.'

For the exhibition, which also featured *Game Changer I*, I made a new series of works called *Histories of Memories,* consisting of an assemblage of various elements that represent the history of external memory devices. They tie together old memory systems and techniques like storytelling, binary coded beads, and shells, and Lukasa memory boards (reminiscent of those used by members of the Mbudye association in the Kingdom of Luba in D.R. Congo), with contemporary memory devices

[30] Marjolijn Dijkman, Jean Katambayi Mukendi, Lo-Def Film Factory (Francois Knoetze & Amy-Louise Wilson) + Joe-Yves Salankang Sa-Ngol, Mimi Onuhoa, Tabita Rezaire, Maarten Vanden Eynde, Analia Saban, Suzanne Treister.

Maarten Vanden Eynde, *Histories of Memories IV*, 2022 (photo: Maarten Vanden Eynde)

like telephones silicon-based microchips, printed circuit boards and fiber optic cables for high-speed trading. They are part of what is called media archaeology, which "not only becomes a method for excavation of the repressed, the forgotten, or the past but extends itself into an artistic method close to DIY culture, circuit bending, hardware hacking, and other exercises that intervene the political economy of information technology" (Parikka, 2015). All the elements are stacked on top of each other, like geological layers of subsequent technological inventions. They are enclosed in a circular frame under a plexiglass dome, resembling old convex Magellan mirrors, or witch's eye mirrors, as they were called in Northern Europe during the Middle Ages, in which you could see yourself and your surroundings, although slightly distorted. In this case, I used the largest cover of a CCTV spy cam to link our obsession with looking into the past and possibly the future. Seven different *Histories of Memories* are made, referencing the largest and most powerful Magellan Telescope, which is under construction and will be operational by 2030. It will use seven gigantic convex mirrors of 8,4 meters in diameter each to peak in space and hopefully answer the most pressing questions of all time: Where did we come from? And are we alone in the Universe?

The domes look like giant amulets or even technological talismans, bringing to mind the small assemblages made by African American artist Betye Saar in the 1980s. Where mysticism and divination took a vital place in her work, I focussed more on the coding and calculating aspect of beads and pearls. I also added raw materials in the equation, like malachite and lithium ore, used to produce the electronic components and the batteries that power them. However, our intention to communicate by merging different communication methodologies is the same. By offering *Histories of Memories* as a magic mirror, the *eye of the witch* can be turned inside out towards the viewer, making them see the world or themselves differently.

Betye Saar, *Sacred Symbols*, 1988 (photo: Brooklyn Museum)

Curating has a similar methodological ontology; it introduces new narratives by reassembling seemingly unrelated works, objects, and concepts. Or, as Roger M. Buergel and Sophia Prinz said when discussing exhibition making, "Essentially, there is a mere constellation of things, a constellation of objects and texts that even may appear contingent, but calls in any case for the visitor's sensory and intellectual collaboration" (Vanden Eynde & Buergel/Prinz, 2021). In that sense, curating is almost like writing, where you try to say something new by using preexisting letters. The visitor's experience depends on the many different words representing the different artworks you can put in dialogue with each other. When done well, the viewer is pulled into one or more stories simultaneously, which will be written slightly differently for everyone because of the subjective epistemological experience.

Research Methodologies

My most crucial research methodology consists of establishing cross-disciplinary collaborations, which include searching for and maintaining long-term relationships with peers and like-minded researchers from other fields of study. To this end, I founded an artist-run initiative in 2005 called Enough Room for Space, together with Dutch artist Marjolijn Dijkman, with the specific aim of initiating cross-fertilization through establishing long-term residency and research projects worldwide. Since the timeframe of this Ph.D. research project is not nearly long enough to achieve a similar goal starting from scratch, I simultaneously collaborated with people I already knew before the start of my research period and made new connections with people I encountered in the networks I was able to join thanks to my involvement in the research group of *Matter, Gesture and Soul*, and the University of Bergen, in which it was embedded.

One exemplary project in this regard is called *On-Trade-Off*, initiated in the framework of the Contour Biennial in Mechelen, Belgium, in 2018 by Picha in Lubumbashi, Democratic Republic of Congo, and Enough Room for Space in Brussels, Belgium. It consists of a temporary collective of 14 artists, researchers, and curators[31] that worked around the importance of lithium for the energy transition into a so-called *green and fossil fuel-free* future. Departing from the recently discovered largest lithium ore reserves found in an abandoned colonial tin mine in Manono in the D. R. Congo, we investigated the influence of its extraction and transformation processes on everyone and everything involved, ranging from the miners who take the lightest metal in existence out of the ground, to the produced batteries that power cars, homes and potentially the entire planet. Using one chemical element (Li3) from the periodic table allowed us to zoom in on particular social, ecological, economic, and political phenomena that are present in almost all production activities since the introduction of the triangular trade in the 16th century: inhumane labor during the exploitation and extraction processes of the raw materials, a perpetuated economic imbalance to maintain economic growth, and uninformed end-consumers that are unaware of the origin and afterlife of their purchased wholesale goods. Exposing the whole chain of production around lithium enabled us to (re)connect the interdependent elements that sustain this recurring imbalance. This is the holistic systems thinking methodology I mentioned in the introduction, and diving into these interlinked histories helped me to ground my focus on external memory devices into a more extensive social and material history. It inspired me to make *A Chain of Events, Future Flora: Manono,* and *What All The World Desires* (made in collaboration with Musasa).

Also, within this research project, as much as in Fontainebleau in France and Blombos Cave in South Africa, it was vital to visit the future extraction site myself, which I did at the start of the project in 2019 together with Congolese artists Jean Katambayi Mukendi and Gulda El Magambo. This field research is an intricate part of my working methods because being in touch with the surroundings, the raw materials, and the people involved is imperative and indispensable. It generates an embodied sensing experience, which is impossible to experience from a distance and necessarily included in the mental and emotional material engagement process.

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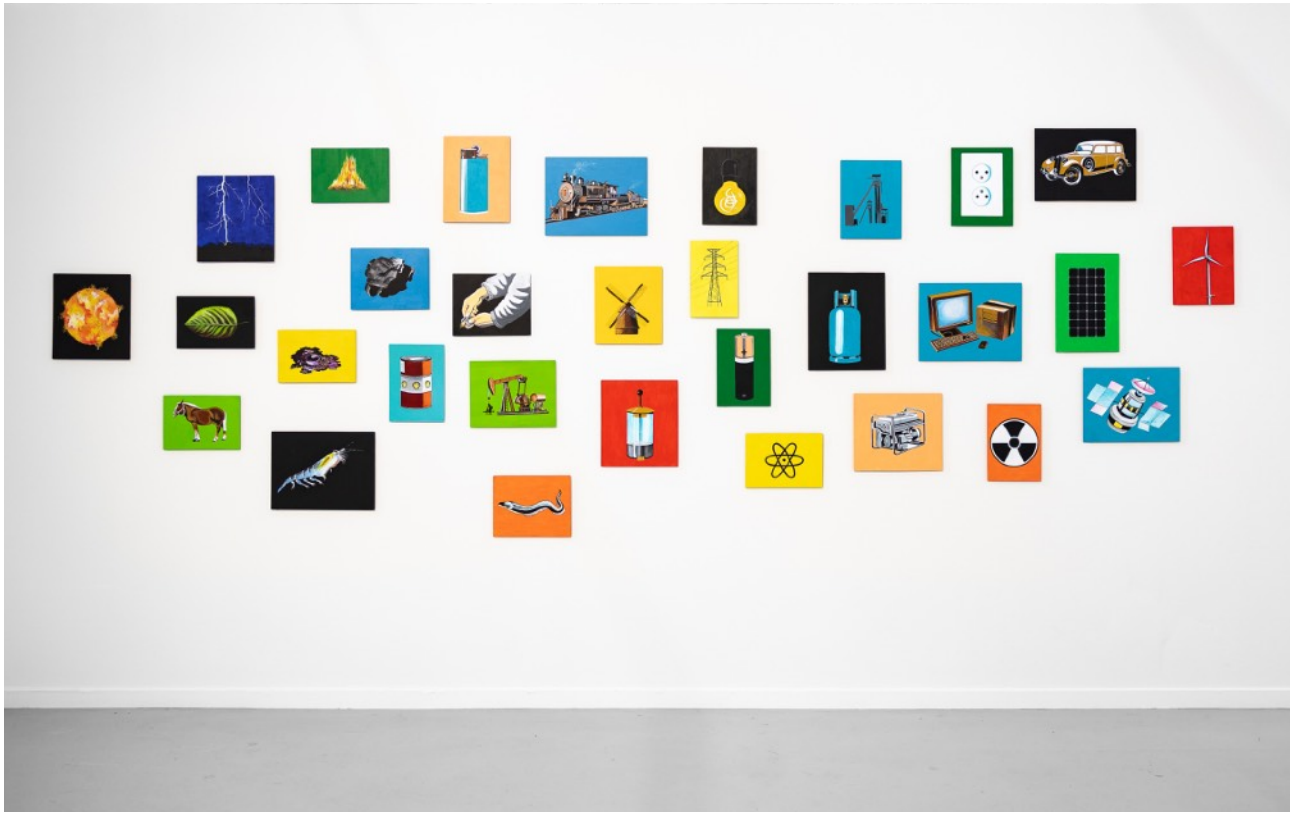
31 Lotte Arndt, Alexis Destoop, Marjolijn Dijkman, Gulda El Magambo, Pélagie Gbaguidi, Oulimata Gueye, Femke Herregraven, Dorine Mokha (†2021), Jean Katambayi Mukendi, Musasa, Alain Nsenga, Georges Senga, Pamela Tulizo, Maarten Vanden Eynde. Formerly involved (2018-2019): Sammy Baloji, Daddy Tshikaya, Rosa Spaliviero.

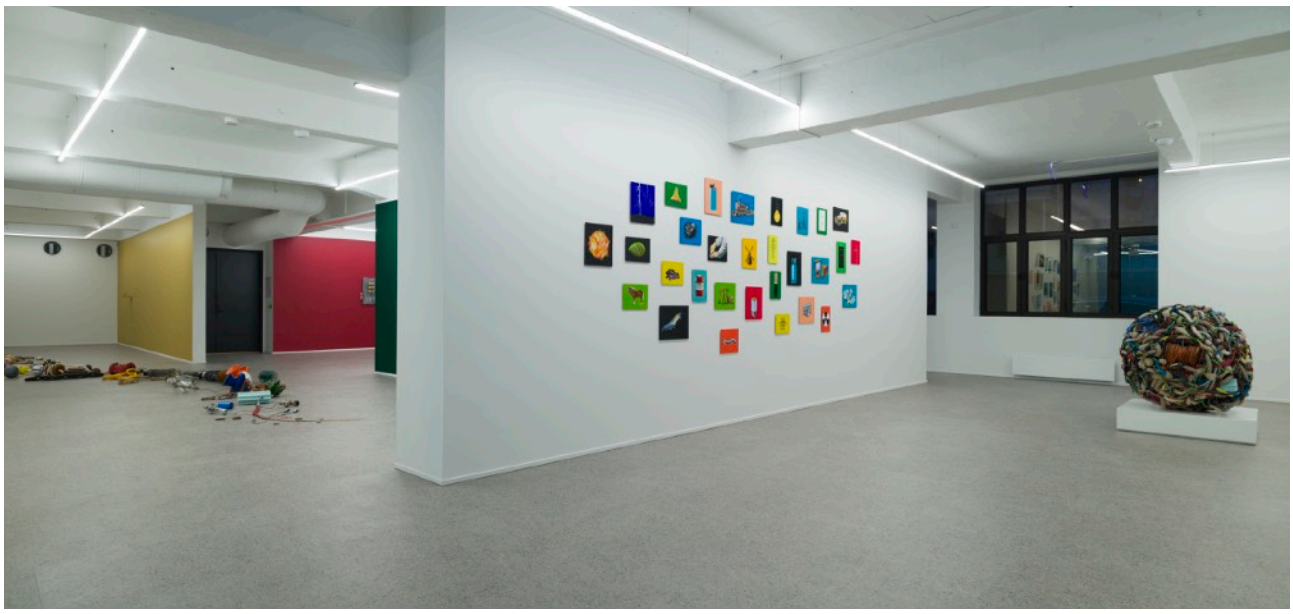


Maarten Vanden Eynde & Musasa, *What All The World Desires,* 2022 (photo: Maarten Nauw).

The project ran from 2018 to 2023, overlapping my PhD project for three years. Countless residencies, round table conversations, artworks, exhibitions, and publications were realized in five years. A final exhibition with most of the newly produced works was presented in Z33 in Hasselt, Belgium, in 2022 and Framer Framed in Amsterdam, The Netherlands, in 2023. The exhibition also included the works *A Chain of Events, What All The World Desires,* and *Future Flora: Manono*, which are all part of my PhD research project and are present in my final presentation.

I realized several works together with Musasa (the artist name for Leu Nseya Musasa). The collaboration started in 2015 during the Lubumbashi Biennial and is more based on visual language exchange, as we paint together on the same painting. We share a particular interest in visual narratives and non-verbal communication and developed a unique style that resulted in a series of works we made together. The last collaboration, *What All The World Desires*, was made for *On-Trade-Off* and involves 30 paintings that tell the history of energy. Each panel, roughly the size of A4, represents a vital material, phenomenon, animal, invention, or technology related to energy production and storage history. There are vertical, horizontal, and diagonal connections between the images, and visitors can imagine shifting them around or flipping them over like in a *Matching* game or a *Memory* game. They use visual language that brings educational charts or wall charts to mind, which are used to explain complex issues or phenomena, and they refer to non-textual memory devices or communication techniques that hint at a universal language that is readable and understandable for everyone, no matter where.

The paintings we make together follow a similar process of production. We discuss the focus or angle to represent a natural element or evolution in the most condensed or simplified way. I make drawings of particular objects, animals, phenomena, or elements, which Musasa paints on a canvas or hardboard. I add specific details and finish the outlines, after



Overview of *The Art to Remember*, Høyersten Contemporary, Bergen, Norway (photo: Bjarte Bjørkum, 2024)

which we decide if the work is representational. Sometimes, the paintings change hands a few times, handing them back and forth, but since we know pretty well how they must look once completed, we usually get it right from the start.

For the exhibition in Framer Framed in 2023, we teamed up with Leonardo Dellanoce and Arthur Steiner from *Memory Gems*, a company that creates site-specific digital souvenirs using blockchain technology, and Aiwen Yin, a designer, artist, and project developer specializing in the social impact of planetary communication technologies, to transform *What All The World Desires* into digital memory tokens. Although it was an adventurous first encounter with blockchain technology, it was unsatisfying not to be able to engage more in a tangible way with *digital matter*. It was a valuable realization for me that tactile communication with the object and subject matter, entering into a dialogue with the material through gestures and activating the motor cortex in the brain, is an essential part of the art-making process.

One of the methods to incorporate this vital exchange and cross-fertilization, as mentioned in the beginning, was to invite three external advisors for the duration of my Ph.D. research period, in addition to my primary and secondary supervisor. I asked Senegalese-French curator and author Oulimata Gueye, British-Polish geologist, palaeobiologist, and author Jan Zalasiewicz, and Cameroonian-French archaeologist, anthropologist and author Augustin F.C. Holl. They all agreed, and I conversed regularly with them throughout my research period.

Oulimata Gueye studies the impact of digital technology on urban popular culture in Africa. We met when we were both mentors of Congolese artist Jean Katambayi Mukendi in the fellowship program of Digital Earth (2018-19),

also initiated by Leonardo Dellanoce and Arthur Steiner. She introduced me to science fiction writer Octavia Butler and wrote one of the essays about my work, *Undermining The Story Of The Future* (Gueye, 2020), for my first monograph. After that, she became part of *On-Trade-Off*, and subsequently, I also asked her to be one of my external advisors during my PhD. Particularly in the first year, her input and involvement were instrumental in the turning point in Fontainebleau, which I mentioned earlier, which led to a paradigm shift from *Digging up the Future* to *Art Memoriae: The Art to Remember*.

From its founding in 2009 until 2020, Jan Zalasiewicz was chair of the Anthropocene Working Group, an interdisciplinary research group as part of the Subcommission on Quaternary Stratigraphy, a constituent body of the International Commission on Stratigraphy, which formalized the Anthropocene in the geologic time scale. He is an Emeritus Professor at the University of Leicester in the UK and also wrote an essay, *Fossils For Future Times*, for my previously mentioned monograph, in which he focuses on human trash strata and the possible material traces that together form the "technosphere" (Zalasiewicz, 2020).
He brought his stratigraphic expertise into the equation, making sure that my assumptions about material behavior and properties throughout time did not divert from current scientific consensus while engaging in wild speculations with me about future scenarios of technological progress and decline. He helped me stay true to the core of my research project and simultaneously encouraged me to think big.

Augustin FC Holl is a rare polymath who found a way to engage with human history and behavior almost accidentally through archaeology, but not a single research topic seems off-topic for him when it comes to understanding the world.[32] His unparalleled expertise and knowledge about human history and evolution in general, with a particular focus on the role of the African continent, was influential and inspirational at the same time. He helped me find blindspots in my research and unearth ungrounded assumptions and conclusions while stimulating me to work academically in a non-academic way. I learned that as much liberty and improvisational freedom can be found within predefined borders and conventions as outside them.

Another method was organizing a unique conversation, a LUNÄ talk[33], for the exhibition Ars Memoriae that was hosted by 601Artspace in New York. Although I participated in several LUNÄ talks before, this was the first occasion where I decided upon the focus and was responsible for curating the company at the table. For each LUNÄ Talk, a different selection of references and artifacts are introduced to start a conversation in combination with objects and stories from a small number of guests. In this case, due to COVID-safe measures still being in place, only seven people were present besides myself.

LUNÄ conversations are intimate, face-to-face, unmoderated, powerpoint-less environments. Instead, the guests are requested to bring with them an object that can kickstart an exciting and thought-provoking conversation that is allowed to continue for hours. The objects can be of historical, personal, or symbolic value. Still, they can also be an image or a book - anything that has a particular resonance for the subject to be discussed around the table that day. The talks are neither recorded nor official minutes, and notes are made, just like the original meetings of the *Lunatics,* as they called themselves.

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[32] He was a Professor at the University of San Diego and Michigan in the US, Universite Paris-Ouest Nanterre La Defense in France, Université de Yaoundé in Cameroun, University Cheikh Anta Diop in Dakar, Senegal, and since 2017, he has been a Distinguished University Professor at Xiamen University, Department of Ethnology and Anthropology in China, where he publishes under the name of Gao Chang. As chair, he supervised the writing of Volumes IX, X, and XI of the UNESCO General History of Africa and is currently Director of the Africa Research Center, Belt and Road Research Institute at Xiamen University, in Fujian, China.

[33] LUNÄ is a work by the Dutch artist Marjolijn Dijkman and consists of a facsimile of the original table around which an influential group of industrialists, poets, inventors, doctors, writers, physicists, chemists, and thinkers known as the Lunar Society met each month in Birmingham, UK, between 1765 and 1813. The society was given its name by the monthly meeting of the members at full moon, during which the participants discussed their latest research, with the aim of learning from each other, and sometimes they would develop projects collaboratively or support each other's projects. Since January 2011, Marjolijn Dijkman used the facsimile table in different locations, including England, Austria, and the Netherlands, for an ongoing series of critical discussions updating topics that occupied the Lunar Men, including new scientific and industrial developments, but also art, education, and social rights.

LUNÄ table at 601Artspace, 2022, New York, US (photo: Maarten Vanden Eynde)

Related to the exhibition concept, the LUNÄ talk focused on media archaeology and the history of technology in relation to memory. The special guests that were asked to bring an object to the table were André Fenton, a neuroscientist at NYU who studies how brains store and experience memories; Elaine Sullivan, a curatorial fellow at The Met and expert on Congolese Lukasa memory boards and the Mbudye *men of memory* who utilize them. She also presented Congolese artist Musasa's audiovisual explanation of these memory devices and their particular use, which I recorded before the meeting when I was working with Musasa on *What All The World Desires* in Belgium. Last but not least, Jennifer Tucker, a historian at Wesleyan University and a specialist on the European Enlightenment period during which the original Lunar society gathered and an expert on the use of audiovisual and photographic material as memory aids. A special guided tour through the exhibition was offered virtually by the co-curator, Oulimata Gueye, who appeared in style on one of the monitors in the installation of Lo-Def Film Factory. Other guests were David Howe, an artist, entrepreneur, and founder of 601Artspace; Christina Savin, assistant professor of Neuroscience and Data Science at NYU, specializing in neural memory circuits in the brain and machine learning; Afiya Zia, a feminist researcher, writer, and activist; and Anthony Goicoliea, an artist working with memorials and monuments for remembering.

The conversation lasted for several hours, followed by a lengthy dinner (as was also customary for the original members of the Lunar Society), focussing on biological memory, external memory devices, and the role of art in implementing methodologies and methods to remember. I was particularly mind-blown by the concept of the zero-sum game that André Fenton brought to the table, which inspired me to continue the conversation in one of the Commodity Frontiers Journals I will talk about next.

Creative Editor for Commodity Frontiers Journal (2020-2023)

Besides engaging and conversing with three additional external advisors (Oulimata Gueye, Jan Zalasiewicz, and Augustin FC Holl), I joined the interdisciplinary research group Commodity Frontiers Initiative (CFI), which aims to systematically catalog, study, and analyze various commodity frontiers over the past 600 years. A bi-annual CFI Journal is produced and edited by scholars and researchers from various disciplines and organizations in the CFI network.[34] Together, they are expert on a wide range of global commodities, covering all the principle-producing regions of the world from the start of the 15th century to the present day, employing a range of approaches, including social and economic history, anthropology, economics, sociology, political science, ecology, and development studies. I became the editor for the creative section and produced five peer-reviewed and published contributions during my PhD, which are also included in the reflection as supplements.

They all focus differently on the role and importance of art making, presenting, or preserving, often through a particular commodity, in relation to remembering and commemorating. I initiated conversations with inspirational people coming from very different backgrounds[35], working in different fields, but at the same time focussing on similar topics related to the human legacy of commodity production and the embedded invisibilizing strategies to obscure knowledge about their place of origin, vital parts of the unhealthy and often inhuman production process, and the toxic afterlife that seems to be a calculated part of it.

The first contribution was *A New Museum Order: Representing the Lasting Legacy of Raw Materials. A Conversation with Roger M. Buergel and Sophia Prinz*. It allowed me to dig deeper into the role of raw materials as storytellers or protagonists within a museum collection or an exhibition. If one manages to engage the viewer or, as Betye Saar proposed, "seduce the viewer" and make them wonder about "What the hell is this?", as Buergel and Prinz said, you have achieved something. By subsequently introducing different elements or pieces of a puzzle close to each other, or in my case, merged together or blended into something new, the momentum of engagement is prolonged. This is the method I used in my final presentation as well. I brought together various materials that, through their transformation, represent memory devices or techniques. Placing them in a particular order creates a narrative that helps the viewer navigate this complex history of human material culture. Hopefully, they inspire the visitor to ask from time to time: *What the hell is this?*

The second contribution was *From Tale to Tail: Unwinding the Twisted Life Story of PIG 05049. A Conversation with Christien Meindertsma*. I spoke with Dutch designer Christien Meindertsma about her very successful book *PIG 05049*, which dissects and lists everything produced from one specific pig. Using an almost opposite methodology, a family tree of narratives emerges from one entity, a pig,

[34] The journal was housed at commodityfrontiers.com through the Open Journal System at Wageningen University in The Netherlands from 2020 to 2022 and currently by the Digital Repository at Brown University in the United States.

[35] Roger M. Buergel is a German curator and the Johann Jacobs Museum's founding director in Zurich, Switzerland. He curated *Mobile Worlds* with Sophia Prinz at the Museum of Arts and Crafts Hamburg, Germany, and was Artistic Director of Documenta 12. Dr. Sophia Prinz is a German cultural theorist and cultural sociologist. She was head of research at the Johann Jacobs Museum. Christien Meindertsma is a Dutch artist and designer. Dr. Ele Carpenter is a British artist, writer, and curator of the Nuclear Culture project, convenor of the Nuclear Culture Research Group, Professor in Interdisciplinary Art & Culture, and Director of UmArts Research Centre at Umeå University, Sweden. Dr. André Fenton is a Guyanese-Canadian-American neuroscientist, Professor of Neural Science, and Director of the Center for Neural Science at New York University in the United States. Pamela Tulizo is a Congolese artist and documentary photographer based in the east of DR Congo in Goma and the founder of TES (Tulizo Elle Space).

instead of one story being told by making assemblages or compositions of multiple items. We talked about the opposing realities of pigs being nearly invisible, whereas the products made of them are omnipresent and hard to miss. At the same time, humans don't know about most products containing pig elements, like cigarettes, bullets, sandpaper, or red wine. After deconstruction, the whole pig is reconstructed by meticulously following the breadcrumbs (or drops of blood). The book became a visual epitaph or monument to pigs in general. Still, because of its uncritical nature, it also became a monument for human ingenuity and resourcefulness by highlighting all the different clever uses of just one animal. This double standard or lack of moral stance makes the book so accessible. The act of showing it is already a statement in itself. How it is interpreted will always remain subjective, depending on many economic and ecological factors and cultural or personal perspectives. Although sometimes I'm outspoken about human actions, I also try to stay as neutral as possible while depicting complex stories. Within visually unfolding them and making connections between overlapping histories or revealing interconnected causes and consequences, there is criticality—hidden truths are often revealed by opposing forces or opinions, like dirty and beautiful or tragic and funny. These seemingly contradicting conundrums are present in almost all my works.

In the third one, *Nuclear Waste Culture: Projecting the Past into the Invisible Deep Future. A Conversation with Ele Carpenter,* we talked about the urgency of nuclear visibility and the deep-time responsibility of radioactive waste storage. And again, like in all complex stories, there are multiple perspectives, depending on what is constituted as waste and what kind of time frame is utilized. "High-level long-lived isotopes are extremely dangerous for millions of years, which is 'forever' at the human scale," aptly put forward by Ele Carpenter (Vanden Eynde & Carpenter, 2022). We talked about waste disposal schemes in relation to colonial and de-colonial practices and the enduring responsibility to keep negotiating radioactive contamination and the process of decolonization into the *longue durée* of the future. "Inheriting is a task" (Haraway, 2010), probably taking humanity's entire lifetime. Dealing with such vast timescales demands knowledge about the longevity of communication techniques and strategies that can survive that long. Artists have been involved since the beginning when imagining how a nuclear waste disposal site can be marked to warn future generations about its potential dangers. Making sure that knowledge and information stay visible, like the aboriginal community in Australia having a continuous culture that goes back over 60,000 years warning about the dangers of uranium in what they call Sickness Country, is probably the best way to make sure that it does not go *out of mind*.

In *Before I Forget: Learning To Live With A Dynamic Memory System. A Conversation with André Fenton*, we talk about how and where memories are stored in the human body. In comparison, biological memories have a very short memory (mRNA or messenger ribonucleic acid, which converts the genetic information within DNA, only lasts a few hours, and the proteins that mRNA makes, which determine human actions and behaviors, only last a few days). In relation to human incongruencies and to ensure that history does not perpetually repeat itself, this *short durée* needs to be remedied. Internally, biology uses the Ship of Theseus paradox, where, bit by bit (or protein by protein), a ship is being rebuilt on the fly (or float), always creating the same ship (or memory) indefinitely. But just like in a *Chinese Whisper Game*, certain bits and pieces are slightly altered along the way, gradually but surely changing the outlines or specific details of the ship or memory. External to the human body, art seems to be humanity's solution for the lack of durability or longevity, using various

transformation processes, rhythm, repetition, and abstraction, for instance, in the function of communication efficiency.

This fourth conversation helped me realize that whatever humans invent as a technology to remember something outside of the human body, they still need the methodology of repetition and renewal to ensure that they understand the same thing. Continuous communication and exchange must ensure that words are understood in the same way, and when they do change meaning because they always do and always will, we need to ensure that we are all still on the same boat (yes, the Theseus). I also appreciated rekindling the notion of the externalization of memory for your own recollection. Any memory device is meant to communicate something to someone, including your future self.

The last contribution was *Fictional Frontiers: On the Fallacies and Fantasies Surrounding Renewable Energy. A conversation with Pamela Tulizo*. Living in and on a 'renewable energy' frontier, artist and documentary photographer Pamela Tulizo experiences firsthand what a dominant narrative does for and to a specific region, in this case, North Kivu in the Democratic Republic of Congo. According to the outside world, mediated by NGOs and media outlets, North Kivu, with Goma as a regional capital, is the epicenter of conflicts relating to mineral extraction. Everything else is invisibilized. Pamela Tulizo believes art can change that limited perception, and I agree. It has always been a catalyst for the transmission of information or experience. It is a tool to communicate, and by gradually repeating a different storyline, the overall narrative can be altered. The abstraction of various elements can re-center people's focus on other things that are valuable for other reasons. Art can help turn the ship around and have it sail to another destination.

What became clear through the various conversations is that I share a particular *modus operandi* with all and every one of the experts I spoke to, namely the incessant interest, curiosity, and drive to, first of all, understand and, afterwards, reveal interlinked phenomena and causes and consequences of complex transformation processes. It goes back to the holistic systems thinking methodology I introduced early on in the introduction.

In a sense, we're all working with a similar methodology, trying to untangle intricacies by investigating something particular in its entirety. The itch to do something comes about after the realization that crucial information is missing in the mediation or narration of a specific property of a material or commodity (rubber, coffee, or a pig), a *miraculous* discovery or solution (nuclear energy or renewable energy), or a historic event or phenomena (colonization, or memory storage) and that consciously obfuscating or invisibilizing certain aspects are an instrumental part of it. "Curiouser, curiouser!" cried Alice when wandering through Wonderland (Carroll, 1865, cited by Loveless, 2019), emphasizing she wanted to know more about the world she did not understand *yet*. The cure involves prolonged probing in the rabbit hole and enduring engagement with the object or subject in question to make the interconnected complexity visible.

Chapter 4: I Forgot …

(inspired by *I Remember* from Joe Brainard, 1970)

I forgot when I started to remember.

I forgot my earliest childhood memory. Whenever I try to picture a place, an event, or an emotion, I see just that: an actual picture from a photo album my parents kept, fully saturated with second-hand stories and after-the-fact references added by other family members.

I even forgot when I realized I could no longer recall my first memory. But it was after I learned from André Fenton, a neuroscientist who specialized in the inner cranial remembering process, that memory is like a zero-sum game. When your memory storage is full, and you want to remember something new, you must erase another memory. I guess I sacrificed my childhood without being aware of it.

I forgot which memories I replaced it with.

I forgot my first spoken word. My mom told me it was 'MORE,' which is exceptional compared to kaka, pipi, cat, mom, or dad.

I forgot I crawled backward first and ended up crying underneath the cupboard because I was getting further and further away from where I wanted to crawl.

I forgot the pain I must have felt when I put my hand on a wood stove. But maybe that's for the better. For a long time, I appear in childhood pictures with a glove over my left hand. And even now, I don't have fingerprints anymore on that hand.

I forgot when I first cut myself accidentally, but I think it was with a Swiss Army Knife (yes, I hear you, Tooby and Cosmides). I fainted and hit my head, falling backwards, which is probably also related to why I forgot it.

I forgot my first alcoholic beverage. Yeah, right….

I forgot the first book I finished reading on my own. The one I did not finish, however, but claimed I did because I was promised a gift afterward was Winnie the Pooh. I got an empty metal box, the size of a thick book, with a series of books of Winnie the Pooh printed on it like a trompe-l'œil. It reminded me ever since of the book I never finished and the empty feeling of lying.

I forgot what my first childhood *girlfriend* looked like. I think she had curly hair, but I'm not sure. Her name was Petra, and we were too young to play doctor naked, so we were not allowed to see each other afterwards anymore.

I forgot when I had my first sexual experience with a boy, but I know it was not the only one. For some reason, practicing to have sex to figure out how to do it before engaging in a romantic relationship with a girl seemed like a good idea. I practiced with a few boys for a few years before I dared or could stop practicing with boys and move to girls.

I forgot when I realized that when a stranger asks you if you want to see something special, you need to run away. My older sister froze when the long coat opened near the train station in Berchem, and I had to pull her away. So, I guess I figured that one out before it happened.

I forgot when candy was a currency. Was it one *Rotella Roll* for a pack of *Jawbreakers*? Or a *Pez* assorted fruit with a *Mickey Mouse* dispenser?

I forgot which one I liked most.

I forgot the name of the truck driver who let me ride in his cabin in Germany for the first time. I could sit next to him, and he had *Milch Erdbeere Bonbons*. They are individually wrapped in paper with a strawberry design and closed on top by twisting the sides of the wrapper together, like a steamed dumpling. The bonbons are red and hard from the outside. When you suck them long enough, a white milky substance comes out. You can also bite, so you don't need to wait so long to have another.

I forgot what name my prematurely born sibling had who came between my elder sister and me. Maybe *it* did not have a name. My mom told me that it was me who came too soon. I had to ascend again and wait a little longer before I could return and be born. Whoever came before me was buried in the garden.

I forgot the smell of my son Louis, who passed away twelve days after he was born prematurely. He was in an incubator in the hospital for his entire life, so maybe that's why he had no smell of his own. I imagine it must have been something like thick, sweet custard cream with a little pinch of flower nectars.

I forgot when I first realized my hands became wrinkled. Now, I check the skin of my hand regularly, and I'm always amazed and a bit shocked about the aging process. Faster than I can mentally cope, I see the hands of an old man emerging. They don't feel like mine, but when I move my fingers, I see that the hands follow suit.

I forgot what clothes I first bought for myself, but they were new, finally replacing the self-made or second-hand clothes I was made to wear when I was growing up.

I forgot if it made a difference in school, where I was bullied during the first four years of undergraduate school. I guess not, or not enough, because we moved to another city when I was ten.

I forgot why people bullied me or who started, but the main class teacher, Paulette, played a big part, as she punished and humiliated me in front of the whole class.

I forgot when I first told my mom.

I forgot that I told her all together. And I don't know what she did or whether it changed anything. She told me a while back that she knew from the start and asked me repeatedly if I wanted to leave every year, but I did not want to go to another school. I didn't want to lose this mental battle. Eventually, I stopped being stubborn, and I did agree to move.

I forgot if I felt relieved or defeated.

I forgot what was said or what they asked during the intake conversation at the new school. Still, on the first day in class, the new teacher, Peter, told me and everyone else that a class is like a very tasty soup, and all the different children are the necessary ingredients to make the soup so tasty. I remember feeling warm inside.

I forgot when I started bullying myself. It was after we moved to the new school for sure. I once read that people who are bullied themselves are the worst bullies. I put a girl's arm behind her back and made her crawl on the floor, barking like a dog.

I forgot if she ever forgave me. I guess so because we ended up having a relationship and planned to live together after high school. On the last day, however, during the graduation party, she kissed someone passionately in the kitchen while I watched. I went home and never saw her again.

I forgot to take the trash out. I know it’s Monday evening, but sometimes I forget it's Monday.

I forgot when the alarm went off every morning to get to school.

I forgot the last time I set an alarm to wake up.

I forgot when I first took a flight on an airplane or where I was going. But I remember that people used to clap when it landed safely.

I forgot the number plate of my first car. It was an orange VW T3 transporter pick-up with a double cabin and a tent, which I had bought before getting a driver's license.

I forgot the landline number from my parents’ house where I grew up. For a long time, I used it as an example of how mobile phones eradicated the necessity of remembering phone numbers. Until a few years ago, I could recall the number at any time. It’s gone now, and I don’t even remember when I stopped remembering it.

I forgot to whom I sent my first letter or postcard. And I forgot from whom I received one for the first time.

I forgot what I wrote in my first email and to whom it was sent. In the 1990s, almost no one had an email address, but that's a lousy excuse.

I also forgot who wrote me an email for the first time or what it was about.

I forgot what job I did to make my own money for the first time.

I forgot how much I made or what I bought with it.

I forgot the first music album I bought. It was a CD, even two, and I remember not having a CD player then.

I forgot when I wanted to become an artist. I was raised in an artistic family, and since my mom had such a hard time making ends meet as an artist, it took a long time for me to be convinced that it was a good idea.

I forgot when my wife and I started dating. Since we both forgot it soon after we met, we settled on June 1st, 2000.

I forgot what she was wearing when I first saw her.

I forgot our first kiss.

I forgot why we thought getting engaged in Xiamen, China, was a good idea. It was in 2008, and the 8 symbolized our eternal engagement since we decided never to get married. Two years later, we married in Rotterdam in The Netherlands, on a boat in the harbor, and I threw the white golden engagement rings in the water.

I forgot where exactly I threw them in the water.

I forgot when I learned to swim. I only remember that it took a long time and that I was the last one in my class who could not swim. I remember finally getting a 25-meter certificate, although I nearly drowned in the process. Drowning is still my biggest fear of dying.

I forgot what I put in my testament. I had to make one when I joined a research expedition on a small sailing boat called *Sea Dragon* that crossed the Atlantic Ocean from Bermuda to the Azores in the winter of 2010. Just over halfway, after sailing safely through the Bermuda Triangle, we ended up in a hurricane with gales of 60 knots and waves of over 10 meters high. It lasted for three days and nights, but we all survived.

I forgot where I put my testament.

Conclusion

During this research period, I plugged into humanity's *mind of many* to find my walking way through a memory palace of inconceivable width and depth. And just like my hominin ancestors, I looked for patterns to make sense of the chaos that is an intrinsic part of the world. Entoptic images stemming from the neurological mesh of the brain presented themselves as visual patterns to early humans. They had to be externalized first through gestures (charades, rhythmic movements, dance) and sounds (knapping stones, chanting, musicking) to communicate with others. Repetition was instrumental in consolidating metaphorical meanings of externalized thoughts and emotions. Grounding and transfixing patterns on matter prologued longevity and enlarged distribution but still included the required presence of humans to read and repeat the symbolic messages. Endless repetition of patterns led to the creation of games, which helped to store, structure, and navigate through large amounts of information. This resulted in methods of remembering that involve walking through a landscape, first a physical one in which meaning was projected and attached to individual elements or phenomena along the way and later in imagined landscapes or buildings in which large datasets and experiences could be stored and revisited later. Once externalized patterns were traced on physical matter, starting with the first stone tools, the variability grew exponentially, resulting in the current plethora of memory devices.

However, as American linguist and author Noam Chomsky put forward, "there is still no substantive 'body of doctrine' about the ordinary creative use of language and other manifestations of creativity" (Chomsky, 2002, cited by Hoffecker, 2011). If art is seen as the output of creativity, then there is ample literature about the subject matter, although maybe not as encompassing or overarching interdisciplinarily as it should be. In my artistic research project, I negated the separating barriers of practitioners within different academic fields of interest by implementing a methodology that embraces "deep interdisciplinarity" (Penny, 2009, cited by Loveless, 2019). One of the methods to remedy this rupture was to not make any distinction between different disciplines, even within the field of (contemporary) art, and instead, look for pieces of the puzzle of the history and evolution of externalization of memory within *any* knowledge system. For this, I used two inspirational concepts. The first one is André Leroi-Gourhan's *chaine opératoire,* an anthropological method of subjectively analyzing the past in a non-chronological sense as a *loopy* chain of events. It helped me move and act freely as an artist within the so-called *hard* sciences like biology and geology. The second is Octavia Butler's concept of *histo-futurism*, which allowed me to merge speculation about the past and the future to create a prolonged now, or a *Long Now,* as English musician and composer Brian Eno would have it. All my works are essentially future memories or remnants of this *Long Now*.

Another methodology consisted of establishing collaborations and conversations with people and materials. One of the methods to achieve this was engaging in interdisciplinary exchange, not only with my supervisors and external advisers but also through published conversations in the framework of the Commodity Frontiers Journal, collaborative research projects like *On-Trade-Off*, and informal gatherings like the LUNÄ talk. Another method was establishing conscious dialogues or *intra-actions* with matter, which I instigated with materials like wood, bone, cotton, silk, glass, ceramic, iron, copper, silicon, uranium, and plastic. They all spoke a different language and were functioning, through skillful manipulation by artists and image makers, as carriers of information throughout human history in various ways. As an artist, I joined the ongoing conversation and spoke *with* them, *for* them, and *through* them, as Tim Ingold suggested. In the exhibition at Høyersten Contemporary

and the presentation at KMD, their act of *mattering* (to speak with Karen Barad) did the same, but this time, because of my bodily absence, they spoke for me.

One of the most influential results of the externalization process of memory (and art-making, for that matter) is the emergence of self-consciousness. When imagining and creating an *outside* memory, an extension of the human body, an *inside* was created simultaneously. The self was placed in relation to everything else. This anthropocentric and self-centered notion came to dominate most human cultures and still holds the human mind hostage. It gives the false feeling of existing independently, not as a part of, but apart from the rest of the world, with all the known consequences. Using DNA computing, current computer technologies will facilitate the reinternalization of memories and other information for the first time since the externalization process started roughly 3 million years ago. Will this also engender an *un*-selfconsciousness process, instigating a renewed feeling of belonging to a larger whole? One would almost hope so.

I threw a stone (tool) into the symbolic sea of possibilities and followed the rhythmic ripples running round and round, slowly but surely coming full circle. This artistic research project allowed me to conclude that artistic expression was used not only to generate the first external memory systems, like symbolic sound, rhythm, and movement, and later also external memory devices like sculpted and painted stones, but that art is, by definition, a memory device. It is the skill to externalize inner emotions, thoughts, visions, and hallucinations and communicate them with others, including a future self. Or, to use cyberspeak in a McLuhanian way, art is offline thinking. Online and offline thinking have different temporalities. Online thinking is reacting to what is there, what reveals itself (images or hallucinations in the dark). In contrast, offline thinking is what is not there anymore or not yet there (remembering and imagining images, i.e., controlled hallucinations).

Art, in the sense of image-making, is not merely a form of 'artification' or a way of 'making something special' (Dissanayake, 1995), but more 'something that needs to be explained in social terms - how it functioned in society, not simply how it promoted survival' (Lewis-Williams, 2002). Art facilitated the expansion and deepening of social relations by enlarging the pallet of communication techniques to share hallucinations and, at the same time, prolonged the longevity of those social relations by leaving longer-lasting traces of that bond, pact, or shared experience.

To formulate an answer to my initial research question about the role of art in the larger history and evolution of external memory devices: art was the spark that lit the fire of symbolic thought and expression and it drew the outlines of every future development of external memory devices, all the way to the invention of binary code. However, art was not just the cause or consequence of the symbolic revolution; it *was* the revolution.

Q.E.D. quod erat demonstrandum

Afterwords

I want to start by thanking those who came before me. Without all the known and unknown hominin ancestors who, through endless trial and error, succeeded in developing exceedingly more complex communication technologies, memory devices, and artistic gestures to express emotions and thoughts, I would be unable to write, and you would be unable to read. They are our kin, in a Harawayan sense, and I stand firm on their stable shoulders while I create these long sequences of 1s and 0s. At the same time, I would like to apologize to those who will come after me. I'm truly sorry, not just for leaving you to live or morph on such a damaged and depleted planet, for which I, as a relay runner, am partly responsible as well, but for most likely misrepresenting you in the conclusions I drew about future developments concerning *Homo sapiens sapiens*. Technological and biological evolutions currently coming into existence point towards a particular future, including the re-internalization of externalized memory systems. However, if one lesson can be learned from the past, the present is not the best foundation to predict the (far) future. For a large part, that is because it is not yet written, which is also a potentially positive thing about it. The future and future history are made and written together by everyone who decides to pick up the metaphorical pen and paper or, to the contrary, throws them away and does nothing. Futuring is a collaborative action or inaction that gives both protagonistic and antagonistic agency and comes with a fundamental and absolute responsibility to everyone involved.

We need to become *good ancestors*, according to Australian philosopher Roman Krznaric, who builds further on long-term thinking that is part of many Indigenous cultures. "The moment has come, especially for those living in wealthy nations, to recognize a disturbing truth: that we have colonized the future. We treat the future like a distant colonial outpost devoid of people, where we can freely dump ecological degradation, technological risk, and nuclear waste and which we can plunder as we please." *Terra nullius* or nobody's land, a doctrine that British colonial settlers used to justify the conquest of native Australian land, became *tempus nullius* or nobody's time, an "unclaimed territory that is similarly devoid of people" (Krznaric, 2020). To reconnect with our ancestors and become good ones ourselves, we should adopt the *Seven Generations Principle,* which obliges people to consider the seven generations that came before them and the seven generations that come after them in every major decision. The Indigenous people of the Iroquois Confederacy mentioned earlier concerning the Wampun memory device are credited as the instigators of the *Seven Generations Principle*, and they even included it in their system of law.

Many artists have attempted to open up or reconnect to a much longer timescale. Scottish artist Katie Paterson instigated the *Future Library* in 2014. It consists of a newly planted forest of 1,000 trees in Nordmarka, just outside of Oslo in Norway, which is used to make the paper for 100 books commissioned over 100 years. Instead of being published, they remain hidden from all possible readers in a unique vault-like safe until 2114. The Austrian artist Martin Kunze has been aiming to preserve "endangered memories" since 2012 with his project *Memory of Mankind* (MOM). It is a preservation project or time capsule depositing 1,000 of the most essential books of humankind 2,000 meters deep in an Austrian salt deposit that originated about 240 million years ago from salt from the ancient Paleo-Tethys ocean to be stored on ceramic micro-film tablets for a million years (Krznaric, 2020). It is uncertain when the mini library will be completed and closed up for posterity. Another attempt to provoke deep time was made by the Long Now Foundation (established in 01996), which cleverly added a zero before the Gregorian calendar to prepare human minds for

a 10,000-year timescale. The prototype of the first *Clock of the Long Now,* or 10,000 years clock, conceived by Danny Hillis in 01986, was activated in 01999. The actual real-size clock currently under construction will be placed on Mount Washington near Ely, Nevada, US, purchased by the Long Now Foundation, especially for the occasion. It is equally unclear when it will be finished, but once it is, it will operate with minimum human intervention for ten millennia. Brian Eno, who gave the *Clock of the Long Now* its name and even coined the term *Long Now* in an essay in 01978, has collaborated with Hillis on writing music for the definitive clock's chimes. Art, as a form of cultural expression, which includes music and writing, is the only magical force humans have to unite and coalesce with deep time. Imaginations and hallucinations write the musical score of human history. Shhhhhhht! Do you hear the bells ringing? It's time to bring this research project to a close, sit down, and forget until the music starts playing again.

I want to thank many living hominini, particularly those who helped me navigate the mysterious maze of human memory, including my own. First and foremost, I would like to thank Geir Harald Samuelsen, the leader and initiator of the research project *Matter, Gesture and Soul* in which my Ph.D. was embedded. Without Geir, this whole endeavor would not have started nor finished; it would simply not have existed. I want to especially thank my main supervisor, Eamon O'Kane, who encouraged me to apply for the Ph.D. position and stayed with me as an unofficial supervisor during the first two years when he could not do it officially. I want to thank the many other main supervisors who, for various reasons, all had to abandon their engagement but who each contributed to the fullest in the short time we had together. In order of appearance: Geir Harald Samuelsen, Jeremy Welsh, Åsil Bøthun, and Brandon LaBelle. My secondary supervisor, Anke Bangma, started and finished with me, although our minds met more than 15 years ago. I sincerely hope that the same amount of stretched time is still waiting for us in the future because her uncanny sharp and critical eye, unwavering attention span, and ability to think in a meta-perspective without losing the red thread are unparalleled. I am deeply indebted to Anke for her persistent presence, overwhelming oversight, and instructing insights. This reflection would be an unreadable collection of 0s and 1s if she hadn't been there to support me and push me beyond my perceived limitations and imagined incapabilities.

I also want to thank my external advisors again: Oulimata Gueye, Jan Zalasiewicz, and Augustin FC Holl. Their exceptional expertise was instrumental in my thinking and making process. They all possess a unique interest and ability to think outside their discipline, and being able to stand on their shoulders was truly inspiring. They all embrace what Natalie Loveless called *polydisciplinamory* and embody a humanity full of continuous curiosity and humbling modesty that I hope to mirror and master one day.

I want to thank the entire staff of KMD for supporting me during my Ph.D., particularly Katrine Hjelde, Frans Jacobi, Anne-Helen Mydland ('Be generous!'), Sabine Popp, and Åse Huus, who gave me valuable advice, suggested specific reading material or helped me at some point to navigate the massive Uluru-like memory palace that the institute can be at times.

I am very grateful to Luca Barbeni and Olga Boiocchi of NOME Gallery in Berlin, Germany, for hosting my midway presentation of my Ph.D. and to Erlend and Simone Aalbæk Høyersten of Høyersten Contemporary in Bergen, Norway for hosting my final presentation, together with KMD.

Also, I would like to thank Ilse Roosens of Mu.ZEE in Ostend, Belgium, Sandrine Wymann of La Kunsthalle in Mulhouse, France and Caroline Daams of Eicas Museum in Deventer, The Netherlands, and Fred Wagemans for curating and co-producing my three retrospective exhibitions and for allowing me to include so many large-scale works in my final presentation. And, of course, this includes the many helping hands that were part of the installation and dismantling of these large-scale solo exhibitions, which are too numerous to mention here.

I'm particularly indebted to Katrina Gregos, who was not only the co-curator for two of my retrospective exhibitions but also the editor of my monograph, *Digging up the Future*, that accompanied the exhibitions. Her curatorial experience and critical eye brought both the exhibitions and the publication to an unprecedented high level, and the valuable lessons I learned from her regarding the importance of the *intra-actions* between the works to generate narrative in the scenography helped me enormously in the making of my final presentation. While we were doing a final round through the first exhibition, she said, "This is an exhibition about exhibition making!" and I knew we were on the right track.

I thank Bernard Steyaert and Wivine de Traux of Mercatorfonds in Brussels, Belgium, who published my monograph for their enduring support, patience, encouragement, and trust. Also, the graphic designers Raf Vancampenhoudt and Lennart Van den Bossche used their magical skills to turn the publication into a work of art.

I thank David Howe and Sara Shaoul of 601Artspace in New York, US, for giving me and Oulimata Gueye the opportunity to co-curate the exhibition *Ars Memoriae*, which became the conceptual backbone of my research project and which allowed me to organize the LUNÄ talk, in the middle of the pandemic, but which proved to be very inspiring and crucial for the remainder of my research. I thank the participating artists in the exhibition: Marjolijn Dijkman, Jean Katambayi Mukendi, Lo-Def Film Factory (Francois Knoetze & Amy-Louise Wilson) + Joe-Yves Salankang Sa-Ngol, Mimi Onuhoa, Tabita Rezaire, Analia Saban, and Suzanne Treister. All the participants at the LUNÄ table: André Fenton, Elaine Sullivan, Musasa (on video-recording), Jennifer Tucker, David Howe, Christina Savin, Afiya Zia, and Anthony Goicoliea. You carried the conversation forward and ensured that we all will never forget what remembering entails.

The leadership of Commodity Frontiers Initiative, Mindi Schneider, Sven Beckert, Ulbe Bosma, and Eric Vanhaute, also deserves to be thanked for their support and carte blanche they gave me as Creative Editor of the CFI Journal to engage in five highly stimulating conversations during my Ph.D. And, of course, my conversation partners, who all gave ample food for thought and who helped me prolongue my self-consciousness by engaging in dialogue: Roger M. Buergel and Sophia Prinz of the Johann Jacobs Museum, Christien Meindertsma, Dr. Ele Carpenter, Dr. André Fenton, and Pamela Tulizo.

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Related to my visits to Fontainebleau, I would like to thank the selection committee of *Art Explora*, Vinciane Despret, Christine Macel, Hans-Ulrich Obrist, Nataša Petrešin-Bachelez, Philippe Vergne, and Koyo Kouoh, for selecting the proposal I submitted together with Oulimata Gueye, and all the people who run the Art Explora residency program, Blanche de Lestrange, Anouk Couturier, Zoé Dailey, and Clara-Lou Sinard, for hosting me and making it possible to be so close to the archaeological site for so long in the middle of the complicated COVID quarantine.
On-site, I would like to thank Alain Bénard of GERSAR, who guided us through the vast Fontainebleau area and pointed out some of the most remarkable petroglyphs.

A special thanks also goes to SapienCE / Centre of Excellence for Early Sapiens Behaviour at UiB, a significant partner in the *Matter, Gesture and Soul* research project, for being so open-minded, helpful, and willing to let me join one season of excavations at Blombos cave, which influenced my Ph.D. beyond recognition and which became the main protagonist of Chapter 1. I want to thank, first and foremost, Christopher Henshilwood, the director, and Karen van Niekerk, the lead investigator, who welcomed me with open arms and never questioned the validity of art as knowledge production; Zarko Tankosic, the project manager, who always had my back and made sure that the residency in South Africa happened; Francesco d'Errico for his groundbreaking work on external memory systems which was truly influential and inspirational for my research; Elizabeth Catherine Velliky who turned me into a proper ochre believer and prepped me mentally for the Western Cape.

On-site, I would like to thank everybody who participated in the excavation season of 2023 for supporting my presence both inside and outside the cave and the lab in Cape Town: Asia Alsgaard, Heidi Øhrn, Jasmin Culey, Lillian Time, Åshild Stuen Jensen, Alexandra Pearson, Lamson Msole, Vita Manda, Åshild Sunde Feyling Thorsen, Lisa Hulett, and Samantha Mienies. We lived in a tiny bubble, almost entirely disconnected from the outside world, and became a temporary family.
I am particularly grateful for being allowed to join the small team that went on a memorable excursion to *De Hoop Nature Reserve*: Simon Armitage ('don't get it right, get it written'), Jenny Maccali, and Zarko Tankosic, which turned out to be one of the absolute highlights.
And, of course, also the University of Bergen for supplying me with a Meltzer grant that allowed me to join and have an unforgettable and profound experience.

Last but not least, I want to thank my actual family, who supported me in making this memory device in its own right. My wife, Marjolijn Dijkman, not only tempted me to start a Ph.D. but also allowed and encouraged me with unwavering enthusiasm to finish it. My parents, Willem Vanden Eynde and Beatrijs Lauwaert, whose DNA ensured I could embark on this adventure in the first place and who, from the sidelines and the front trenches, have always been my biggest supporters. And my sons Jules and Louis, who departed too early to be part of the world but who filled my heart along my artistic, intellectual, mental, and emotional journey.

I will never forget you.

Timeline of activities from September 2020 to March 2024

Black: exhibitions with work made in the framework of this PhD project
Light grey: exhibitions with works made before this PhD project

September 2020:

- Presentation at Taking Care - Ethnographic and World Cultures Museums as Spaces of Care: Thinking With | Macarena Gómez-Barris | The Extractive Zone. A project by The Research Center for Material Culture in Leiden, The Netherlands.
- Group show: 'Inspire,' Iselp, Brussels, Belgium > existing work: *The Overview Effect*.
- Group show: 'Chasing Flowers,' Coup de Ville 2020, different venues in Sint-Niklaas, Belgium > existing work: *The Great Decline*.
- Group show: 'Zin Ex. From Abstraction to Algorithm,' TABAKALERA, Donostia / San Sebastián, Basque Autonomous Community, Spain > existing works: *Future Flora: Manono* and *Malachite Mobiles*.
- Group show: 'Dreaming in Everywhen,' IMPAKT FESTIVAL 2020, at Impakt Center for Media Culture, Utrecht, The Netherlands > existing work: *The Great Decline*.

November 2020:

- Group show: 'Vision and Horror of Modernity - Industry and Artistic Departure,' The Von der Heydt-Museum, Wuppertal, Germany > existing work: *Continental Drift*.

December 2020:

- Publication of my first monograph, 'Digging up the Future' in French, English, and Dutch. Published by Mercatorfonds, Brussels, Belgium. Distributed internationally by Yale University Press.

January 2021:

- Teaching workshop: Three-day workshop about representing your art practice in a portfolio, on websites, and within grant applications. HISK / Higher Institute of Fine Art, Ghent, Belgium.

February 2021:

- Presentation for MA students at KMD, Bergen, as part of: What Future? Life on the planet, queer futurity, and predictive technologies.

April 2021:

- Publication of article: 'A New Museum Order: Representing the Lasting Legacy of Raw Materials. A Conversation with Roger M. Buergel and Sophia Prinz.' As part of the 2nd Commodity Frontiers Journal.
- Group show: 'Zoology,' Zebrastraat-New Zebra, Ghent, Belgium > existing work: *End Game*.
- Presentation at EURO—VISION Assembly: Recommendations for Post-Extractive Futures by Arts Catalyst and Radar, London, UK.

May 2021:

- Group show 'Beaufort 21', Triennial all along the Belgian coast > existing work: *Pinpointing Progress*.

June 2021:

- Presentation at Cité International des Arts in Paris as part of Art Explora.
- Research residency: June, July, and August 2021, in Cité International des Arts, Paris, France. Exploration of the Fontainebleau area, France.
- Group show: 'In Situ - MoMeNT,' Gallo-Romeins Museum, Tongeren, Belgium > existing works: *IKEA Vase*, 2011 + new work:

Chihuahua Footprints Discovered!

August 2021:

- Group show: 'DIG IT UP AND PUT IT IN A BAG,' University Museum of Bergen, Norway > new work: *Game Changer*.
- Publication of essay: 'Writing History, An Imaginary Mnemonic Game Changer,' in Palimpsest publication, Art Academy—Department of Contemporary Art, Faculty of Fine Art, Music and Design, University of Bergen, Norway.

September 2021:

- Retrospective solo show: 'Digging up the Future,' Mu.ZEE, Ostend, Belgium > 26 existing works and three new works: *A Chain of Events, The Points of No Return,* and *Check Mate*.

October 2021:

- Publication of article: 'From Tale to Tail: Unwinding the Twisted Life Story of PIG 05049. A Conversation with Christien Meindertsma.' As part of the 3rd Commodity Frontiers Journal.

November 2021:

- Artist talk: 'Ars Memoriae; The Art to Remember,' SapienCE, Centre for Early Sapiens Behaviour, UiB, Bergen.

March 2022:

- Co-curated group exhibition: 'On-Trade-Off: Charging Myths' with On-Trade-Off collective, Z33, Hasselt, Belgium > existing works: *Material Matters; Li3*, 2018 and *A Chain of Events*, 2021 + new works: *Future Flora: Manono*, and *What All The World Desires* (in collaboration with Musasa).
- Group show: 'Welcome to Amchitka: area to be avoided,' 38cc, Delft, The Netherlands > existing work: *Half Life*, 2019.
- Co-curated group exhibition: 'Ars Memoriae,' with Oulimata Gueye, 601Artspace, New York, United States > existing works: *Technofossil*, 2015, and *Game Changer*, 2021 + new work: *Histories of Memories*.

April 2022:

- Solo show: 'Memory Devices,' Art Brussels solo, Meessen De Clercq gallery, Brussels, Belgium > existing work: *The Great Decline*, 2019, and *Histories of Memories*, 2022 + new works: *Blockchain, Memory of Man, 1001 Mermaid Tears, Game Changer II*.
- Group show: 'Design Fest Ghent,' Ghent, Belgium > existing work: *A Chain of Events*, 2017.

May 2022:

- Research residency: The Weatherhead Initiative on Global History, Cambridge University, Boston, and The Neurobiology of Cognition Laboratory, New York University, United States.
- Initiated and coordinated seminar: 'LUNÄ talk,' in 601Artspace, New York, with André Fenton, a neuroscientist at NYU who studies how brains store and experience memories; Elaine Sullivan, a curatorial fellow at The Met and expert on Congolese Lukasa memory boards and the Mbudye *men of memory* who utilize them. She presented Congolese artist Musasa's audiovisual explanation of these memory devices and their particular use, and Jennifer Tucker, a historian at Wesleyan University and an expert on using audiovisual and photographic material as memory aids.
- Group show: 'Chapter 5IVE,' Het HEM, Zaandam, The Netherlands > existing works: *Material Matters,* 2018-2019, and *The Great Decline,* 2019.
- Group show: 'Lille 3000: Utopia,' Gare Saint Sauveur, Lille, France > existing works: *Malachite Laptop (XO-OLPC)*, 2017, and *The Last Human,* 2017.

June 2022

- Retrospective solo exhibition: 'Exhumer le future,' La Kunsthalle Mulhouse, France > 26 existing works + new work: *Fat Man 3D*.

- Group show: 'One World – Power of the Four Elements,' Schloss Ambras Innsbruck, Germany > existing work: *1000 Miles Away From Home*, 2009-2013.

September 2022:

- Solo show / Midway presentation: 'Tracing Memories,' NOME gallery, Berlin, Germany.

- Artist talk: 'Drawing the Line/ On Signs and Signifiers in Art and Artefacts,' SapienCE, Centre for Early Sapiens Behaviour, UiB, Bergen.

- Group show: 'PARS PRO TOTO,' SB34 — Clovis, Brussels, Belgium > existing work: *Brick Era*, 2003-2013.

- Group show: 'The Hidden Side of Lace,' CC De Ververij, Ronse, Belgium > existing works: *Fat Man, Little Boy, The Gadget,* 2016, and *The Gadget 3D*, 2017.

- Group show: 'You Know Who,' Abdülmecid Efendi Mansion, Istanbul, Turkey > existing work: *Oil Peak*, 2013.

November 2022:

- Artist talk: In the framework of 'Deep histories fragile memories artistic research cluster,' LUCA School of Arts, Brussels, Belgium.

- Group show: 'Point de Bascule,' Cloître des Récollets, Metz, France > existing work: *Restauration du Lac de Montbel*, 2003

- Group show: '*FINIS TERRAE / The End. A Beginning*,' Antwerp, Belgium > existing work: *Plastic Reef*, 2008-2012.

December 2022:

- Publication of article: 'Nuclear Waste Culture: Projecting the Past into the Invisible Deep Future. A Conversation with Ele Carpenter.' As part of the 4th Commodity Frontiers Journal.

February 2023:

- Co-curated group exhibition: 'On-Trade-Off: Charging Myths' with On-Trade-Off collective, Framer Framed, Amsterdam, The Netherlands > existing works: *Material Matters; Li3*, 2018; *A Chain of Events*, 2021; *Future Flora: Manono*, 2022, and *What All The World Desires* (in collaboration with Musasa), 2022.

- Group show: 'Sub Terra,' La Maison des Arts, Brussels, Belgium > existing work: *Malachite Mobiles*, 2015.

- Research residency: February/March 2023: Blombos Cave and Cape Town, South Africa. As part of the excavation period of SapienCE, Centre for Early Sapiens Behaviour. With Meltzer grant from UiB, Bergen.

March 2023:

- Artist talk: as part of 'More-Than-Human Encounters,' a collaboration of VUB Crosstalks and Kaaitheater, Framer Framed, Amsterdam, The Netherlands.

- Group show: 'Compulsive Desires: On Lithium Extraction and Rebellious Mountains,' Galeria Municipal do Porto, Portugal > existing works: *Material Matters; Li3*, 2018, and *Future Flora: Manono*, 2019.

April 2023:

- Group show: 'Seeds of Memory,' Fries Museum, Leeuwarden, The Netherlands > existing work: *Future Flora: Fungurume*, 2022.

- Group show: 'En Regard,' Le Delta, Namur, Belgium > existing work: *Horror Vacui*, 2016.

- Group show: 'Through Bone and Marrow,' BRUTUS, Rotterdam, The Netherlands > existing work: *The Last Human*, 2017.

- Group show: Art Brussels, MSSN gallery, Brussels, Belgium > new works: *Blombos Time Ball*, and *Tenerife Tech*.

May 2023:

- Publication of article: 'Before I Forget: Learning To Live With A Dynamic Memory System. A Conversation with André Fenton.' As part of the 5th Commodity Frontiers Journal.

June 2023:

- Group show: 'Grondtonen,' Ijsselbiennial, The Netherlands > new work: *The Origin of Objects*.
- Solo show: 'Gravend naar de toekomst,' Museum EICAS, Deventer, The Netherlands > 25 existing works.

July 2023:

- Group show: 'Elefsina Mon Amour: Towards a Third Paradise' - 2023 Eleusis European Capital of Culture, Elefsina, Greece > existing works: *A Chain of Events*, 2021; *Memory of Man*, 2022, and *Technofossil*, 2015.
- Research residency: preparatory research for Manifesta15, with On-Trade-Off collective, Barcelona, Spain.

August 2023:

- Group show: 'Shifting Sceneries / 1st GIST Triennale,' Zenne Valley, Belgium > existing works: *Half Life*, 2019; *Future Flora: Manono*, 2022; *What All The World Desires*, 2022 + new work: *The Gordian Knot*.
- Artist talk: as part of 'Shifting Sceneries / 1st GIST Triennale,' Zenne Valley, Belgium.

September 2023:

- Group show: 'The Stuff of Life | The Life of Stuff,' Sainsbury Centre, Norwich, United Kingdom > existing work: *Check Mate*, 2020 — ongoing.

October 2023:

- Live conversation with Lisa Doeland, philosopher and author of 'Apocalypsofie': as part of my retrospective exhibition and Museumnacht, Eicas/European Institute for Contemporary Art and Science, Deventer, The Netherlands.
- Group show: 'Bodies of Water - KIKK festival 2023,' Namur, Belgium > existing work: *Plastic Reef*, 2008-2012.
- Group show: 'Wasteland Festival 2023: Streams of Waste,' Den Hague, The Netherlands > existing work: *Palaeontological Plastic IV*, 2014.
- Group show: 'Les Heures Sauvages: Nef des Marges dans l'ombre des certitudes,' Centre Wallonie-Bruxelles, Paris, France > existing work: *The Last Human*, 2017.
- Group show: 'This Is Us,' Z33 - House for Contemporary Art, Design & Architecture, Hasselt, Belgium > existing work: *Plastic Reef*, 2008-2012.

November 2023:

- Group show: 'Elemental Constellations,' Macalline Art Center, Beijing, China > existing work: *Material Matters*, 2018-2019.

December 2023:

- Publication of article: 'Fictional Frontiers: On the Fallacies and Fantasies surrounding Renewable Energy. A conversation with Pamela Tulizo.' As part of the 6th Commodity Frontiers Journal.

January 2024:

- Group show: 'Sculptura #2', Gare Maritime, Brussels, Belgium > existing work: *The Origin of Objects*.

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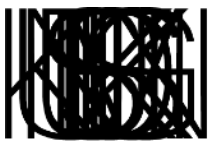
Errata

Page 8: clarity correction: “in the framework of my artistic research project” is erased
Page 54: clarity correction: “French” is added in “…protected by the French royal family and King Henry III…”
Page 64: spelling error: ”scrips” corrected to “scripts” line 11
Page 69: spelling error: “Marschall McLuhan” corrected to “Marshall McLuhan“
Page 74: language error: “in the framework of” corrected by “on the occasion of”
Page 82: language error: “in the framework of” corrected by “for”
Page 83: language error: “in the framework of” corrected by ”for”
Page 98: language error: “in the framework of” corrected by ”for”
Page 99: language error: “in the framework of” corrected by ”by”
Page 108: language error: “in the framework of” corrected by “as part of”
Page 120: language error: “Inadmissible” corrected to “indispensable”
Page 120-1: clarity correction: “in the framework of” is erased
Page 121: language error: “in the framework of” corrected by ”for”
Page 123: language error: “in the framework of” corrected by ”for”
Page 123: language error: “convert” corrected by “divert”
Page 134: clarity correction: “in the framework of” is erased
Page 136: spelling correction: ”Olso” corrected to ”Oslo”
Page 140-1: language error: “in the framework of” corrected by ”for”
Page 140-2: language error: “in the framework of” corrected by “as part of”
Page 140-3: clarity correction: “in the framework of” is erased
Page 140-4: language error: “in the framework of” corrected by “as part of”
Page 141: clarity correction: “in the framework of” is erased
Page 142-1: language error: “in the framework of” corrected by “as part of”
Page 142-2: clarity correction: “in the framework of” is erased
Page 142-3: language error: “in the framework of” corrected by “during”
Page 142-4: language error: “in the framework of” corrected by “as part of”
Page 143-1: clarity correction: “in the framework of” is erased
Page 143-2: language error: “in the framework of” corrected by “as part of”
Page 143-3: language error: “in the framework of” corrected by “during”
Page 143-4: clarity correction: “in the framework of” is erased



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A New Museum Order: Representing the Lasting Legacy of Raw Materials: A Conversation with Roger M. Buergel and Sophia Prinz

Maarten Vanden Eynde

Keywords: museology, art, human history, raw materials, globalization, colonial heritage, relational aesthetics, interdependency, transculturalism, temporality, memory, remembering

In the framework of the 2nd Commodity Frontiers Initiative Journal with the theme of 'Stimulants' I could not have wished for a better-suited match to interview than Roger M. Buergel and Sophia Prinz from the Johann Jacobs Museum, which owes its existence to the coffee and cacao trade, but more importantly is unique in its endeavour to lay bare the intrinsically interwoven histories of commodities. The museum is dedicated to the global interdependencies of our life-world that become especially clear when tracing the history of important trade goods and their transport routes.

Maarten Vanden Eynde: *What intrigued me most about the statements that feature on the website of Johann Jacobs Museum, and more particularly in the research section about Raw Materials, is the part about the influence of the distribution of scarce resources on human history. It introduces the importance of cocoa and coffee, but also gold, crude oil, rubber and rare earths, as storytellers or protagonists in a story. 'Telling these stories is one thing' it states. 'Being able to interpret them is another matter entirely. And yet that is exactly what our exhibitions aim to do: use raw materials as a guide for deciphering how our modern world works.' Could you elaborate on how these materials, or the objects and documents that are used to tell their story, communicate, or how they are aided within the museum to speak about their previous life, use and importance?*

***R*oger M. Buergel / Sophia Prinz**: Curatorially speaking, the first thing to do is to turn the material, be it opium, coffee, rubber or diamonds, into something strange. You want to induce people to digest the material's presence, apart from any idea, or even promise, of narrative. There are some devices we tend to borrow from post-conceptual installation art, e.g. highlighting a material in its obstinate being-thereness. If you can make people ask in front of a piece of rubber: 'What the hell is this?' then you have already achieved something. The second thing to do — again, curatorially speaking — is to keep the momentum, the sense of slight irritation that encroaches upon you as a visitor if the museum refuses to tell the truth, to explain, to enlighten you, whatever. You share a space with, say, a piece of natural rubber (caoutchouc), and next you see in a corner of the gallery a tiny photograph (black-and-white, dating back to the era of King Leopold's plunder) of a Congolese whose skin is almost covered with rubber. Or you encounter a small screen with a movie by Melanie Smith about contemporary Fordlandîa: images absorbing jungle life that has reconquered the by now ruined factories and facilities brought by Henri Ford to the Amazon Rainforest in the late 1920s. Visiting the exhibition and contemplating the different objects, you are hardly overburdened with information. But you are fed bits and pieces that tickle your imagination of the big picture. On it goes to the next gallery where you get more bits and pieces. This, in a nutshell, is our curatorial method. There is hardly a story or only of the shaggy dog-variety. There is no clear timeline, no authorial categorial framework (departments of „South America", "Islam" or „Modernity", for example), although with some luck you might stumble into a department for "rubber"…. Essentially, there is a mere constellation of things, a constellation of objects and texts

that even may appear contingent, but calls in any case for the visitor's sensory and intellectual collaboration.

MVE: *Isn't this constellation of things, or the breadcrumbs that are left throughout the exhibition, still semi-consciously curated though? Or do the cross-references, narratives or historic links reveal themselves after the fact, after the opening of the exhibition? If you take coffee or cacao for instance, which are very much related to the history of Johann Jacobs Museum, I can imagine that there are too many objects, documents and photographs to show all of them at once. So a selection needs to be made, and by making that selection, one is already assembling the pieces of a complex puzzle that hopefully will be made whole by the visitor.*

RMB/SP: The Johann Jacobs Museum has no collection proper except for a few pieces to which we will come back in a minute. All our exhibitions on global trade and the migration of form are based on loans or collaborations with artists. But to answer your question about the curatorial process first: yes, curating is no dreamwork, the choices are made deliberately and sometimes intuitively too. This said, you cannot plan, control or determine how people look and relate to objects or constellations of objects. Some people will prefer a sense of direction, a kind of museological order imposed by the institution (allowing them to walk from the "19th century" to the "20th century, for example). Other people might actually like to get lost — as in Venice where getting lost gives you a chance to discover something new. In short, there is play at work in curating and the visitor has to accept it, which in turn implies that his or her "will to know" gets curtailed severely. Fundamentally, the exhibition experience is an aesthetic experience — a type of experience that forces you to reflect upon your expectations and assumptions as well as on your habitual modes of perception and understanding. Aesthetic experience paves the way for a more nuanced understanding of one's own role in the world. The ground is slippery though... While the Johann Jacobs Museum is indeed connected to coffee and cocoa — the endowment of the Jacobs Foundation of which Johann Jacobs Museum forms a part, was generated by a coffee brand (Jacobs), while the Jacobs Holding is a majority shareholder of Barry Callebaut[1] —, there is no collection worth its name except for a few pieces.

There is a coffee pot, for example, that was commissioned by the VOC in Jingdezhen around 1700. While the model, including the decorative design, came from Dutch craftspeople, it was up to Chinese potters and porcelain painters to turn the pot it into something real. But what do you do as a Chinese painter if you cannot identify a Dutch windmill? You have never seen a windmill in China, and thus you render it as… a flower! In other words, the pot is both a result of global trade between China and the West, and the carrier of a brilliant cultural misunderstanding. This is the kind of story you can tell but, perhaps, you also want to talk about the blue colour and the cobalt from which it was derived…

MVE: *Given the complex nature and intertwining history of the wide variety of raw materials, how does the museum facilitate the surfacing of these embedded stories, taking in account the often contradicting memories or emotions that are connected to them? How do you include multiple perspectives for instance, or a 'heterogeneity of voices' when talking about the same historic event? How do you display contradictory temporalities?*

RMB/SP: The Chinese cobalt for potters in Jingdezhen came from Persia, and was paid for with silver the Spanish extracted from mines in South America. Today's cobalt comes from the Democratic Republic of the Congo and drives batteries. The piece of rubber mentioned above allows you to connect the ecology of the plant with the first telegraph cable between Europe and the US. We think that these phenomena are less contradictory than complex. They appear contradictory only if you insist on a certain order of knowledge. True, museums, being both brainchild and Western treasure troves of the long 19th century tend to reproduce this order. This is one more reason for wanting to get rid of them, as in the "Mobile Worlds" exhibition, but more to that later.

[1] Barry Callebaut is among the world's largest cocoa processors and chocolate manufacturers, with an average annual production of 2.1 million tonnes of cocoa & chocolate.

«A Season in Shell» by Zheng Mahler, Johann Jacobs Museum 2013/14, installation view, courtesy JJM.

The „multiple perspectives" you are claiming should in our view be part of the museum's *modus operandi*. There is for sure an emphasis on multiple perspectives, participation and diversity in today's museum world, but this emphasis tends to remain exterior to the exhibition form. It is a political marketing ploy, nothing more. If an institution is truly interested in multiple perspectives, it has to leave the curatorial comfort zone and start undoing the institutional architecture, including its power structure. For instance, you have to invent ways of working on eye-level with miners in Kivu[2] and also with Glencore[3]-traders, knowing fully well that such a method (if improvisation is a method) won't guarantee an outcome. As a rule, curatorial work becomes interesting at the point at which the exhibition-form is not treated as a given. Collaboratively, with the Kivu-miners and the Glencore traders, you have to invent a way of dramatizing the material, cobalt or coltan, for example. Then you stand a chance to arrive at multiple perspectives. In other words, multiple perspectives won't happen if they are not built in from the beginning—an integral part of the project's texture.

MVE: *This sounds almost 'to good to be true', being able to include such a variety of voices in the making of the exhibition, but is this already in practice an actual part of the Johann Jacobs museums modus operandi, or are you referring to museums in general? If you are indeed talking about the Johann Jacobs Museum, could you give some examples of successful outcomes of this improvisation method, implementing these 'multiple perspectives' and letting them solidify in the final outcome?*

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[2] Kivu was the name for a large region in the Democratic Republic of the Congo under the rule of Mobutu Sese Seko that bordered Lake Kivu. It included three sub-regions: North Kivu, South Kivu and Maniema, corresponding to the three current provinces created in 1986.

[3] Glencore is an Anglo-Swiss multinational commodity trading and mining company supplying metals, minerals, crude oil, oil products, coal, natural gas and agricultural products worldwide.

RMB/SP: We can talk only about our own work but, of course, many colleagues share similar ideas. More importantly, many artists like Allan Sekula for example, were after this type of improbable encounter. It is tough so because the attempt to engage communities or individuals with completely different mindsets can be quite frustrating, even though the outcome might prove fruitful. But there is no alternative if you want to reach a level of curatorial formalization that is not determined by the visible or invisible confines of institutional architecture (the written or unwritten rules of how to do things).

The term „successful" is a double-edged sword too. If you work with fragile people, migrant teenagers from the Middle East or Africa with no residence permit, for example, you might be able to achieve something. But there is nothing you can or want to show, because you need to shield the teens from the authorities. Still, working with these teens is extremely enriching as they both know and understand a lot about, say, gold mining in Ghana, piracy in Somalia or the Chinese presence in Africa. They are your experts albeit not in the official sense of the word. And they are your audience too.

MVE: *Coming back to the modus operandi of museums, is this also relating to the 'new museum order', as proposed in the exhibition "Mobile Worlds or the Museum of our Transcultural Present" that took place in The Museum für Kunst und Gewerbe Hamburg (MKG) in 2018, in which the traditional departments such as 'antiquity' and 'modern', 'European' and 'Asian' or even 'art' and 'non-art' were merged in order to represent society's transformation as a result of globalization? There was hardly any contextualisation of the exhibits on display, and interpretation was left largely to the visitor. Can you talk a bit more about this approach and the way in which it was perceived?*

RMB/SP: *Mobile Worlds* followed a slightly different track then what we do at Johann Jacobs Museum. The Museum of Arts and Crafts Hamburg (MKG) has an encyclopedic collection similar to the V&A[4]. This type of museum was a fruit of the World Exhibitions, even literally, as its founding director went on shopping sprees to Vienna in 1873 and Paris in 1900.

The challenge was to come up with an exhibition model that would do justice to some global political entanglements of the 19th century, between Western powers and Japan, for example, or between Europe, the Carribean and Brazil, and the African West Coast. Differently put, could we make objects reveal certain political patterns or layers while involving the visitor in the exhibition's compositional moves?

The visitors were not completely left on his or own; there was a catalogue. Still, you want people to have a chance of making their own moves and do their own imagining and thinking. Alois Riegl, the eminent Viennese art historian and contemporary of Freud, talked about „attentiveness". If you neutralize the intellectual and aesthetic challenges or explain away the problems, you condemn people to consumerism. They become dull rather than attentive. To give you an example from Mobile Worlds, look at this football.

The football was displayed suspended in a vitrine, referencing Jeff Koons' *One Ball Total Equilibrium Tank* (1985). Art people would get it and make the link to a post-Duchampian discourse on art and ontology. Other people would just be happy to encounter a football, children certainly. The football is even signed —by Pelé (or Edson Arantes do Nascimento), one of the greatest players of all time. Some visitors will become sentimental about the 1970s and, perhaps, share their memories. If you look closer at the signature, you realize that Pelé was drawing a spiral. What could be the meaning of the spiral?

A few steps away from the football you encounter a bowl from Bahía (the Brazilian North-East), a loan from the Lina Bo Bardi[5]-collection of folk art. There is a spiral on that

[4] The Victoria and Albert Museum in London is the world's largest museum of applied and decorative arts and design, as well as sculpture, housing a permanent collection of over 2.27 million objects. It was founded in 1852 and named after Queen Victoria and Prince Albert.

[5] Lina Bo Bardi (1914-1992), born Achillina Bo, was an Italian-born Brazilian modernist architect who devoted her working life to promoting the social and cultural potential of architecture and design.

Football, signed by Pelé», from the Docker's Museum by Allan Sekula, at «Mobile Worlds» (2018), Museum of Arts and Crafts Hamburg, courtesy M HKA, Museum of Contemporary Art Antwerp, Belgium.

Installation of coffee paraphernalia on the wall of Johann Jacobs Museum, courtesy JJM.

bowl, too. In fact, the spiral is a deeply ingrained motive in Afro-Brazilian decorative patterns. Next you encounter a piece of West African-textile with a spiral-pattern, and next to it a photograph by Guilherme Gaensly that was shot at the port of Santos. It shows carriers with heavy sacks of coffee on their backs, ready to bring them on board of a ship destined for Hamburg. Slowly but surely the few coffee beans spilled under the football start to make sense. You draw the connection between African textiles, the slave trade, plantation colonialism, coffee, the port city of Santos and FC Santos, the club of Pelé. In our view, this is the way to show coffee beans in an exhibition that addresses global trade, the museum's colonial heritage and Western fictions of planetary order.

MVE: *Is the experience of the visitor in the museum mainly visual, i.e. through the reading of text or the viewing of illustrations or images? Or is there also a focus on other senses, like hearing, smell or touch?*

RMB/SP: With Zheng Mahler from Hong Kong (an artist and anthropologist-couple) we staged an exhibition in 2013 that basically consisted of 2 tonnes of Abalone-shells. „A season in shell", this was the exhibition's title, addressed the low end of global trade between China and Africa, featuring a Somali trader who shipped the Abalone from Somaliland via Zurich to China. As you will guess that this was complex project, containing infinite layers, and logistics (shipping animal products, and so on) was nightmarish. Precisely because of its nightmarish character, it was also revelatory and entertaining. The shells, when they arrived in Zurich and were brought to the gallery, smelled like hell. After a couple of hours, the offices had to be evacuated. In other words, sensual experience matters a lot, but it would be naive to attribute it a critical function *per se*. Curatorially speaking, the difficulty lies in organizing or articulating a sensual experience like smell, and to use the senses in order to challenge perceptual habits.

MVE: *Thank you Roger M. Buergel and Sophia Prinz for your time. I think we touched upon some vital issues of exhibition making and the possibilities of objects to communicate complex interrelated stories about commodity frontiers. I would love to hear more about it, but we reached the limit of our word count, and I smell some fresh coffee being brewed somewhere... Time for a break!*

Chinese blue and white 'Europa and the bull' coffee pot, Kangxi (around 1700), courtesy JJM.

Roger M. Buergel is the founding director of Johann Jacobs Museum in Zurich. He curated «Mobile Worlds» with Sophia Prinz at the Museum of Arts and Crafts Hamburg (2018), «Suzhou Documents» with Zhang Qing at the Suzhou Art Museum (2016), «Garden of Learning» at the Busan Museum of Art in South Korea (2012), and was Artistic Director of documenta 12 (2007).

Dr. Sophia Prinz is a Cultural Theorist and Cultural Sociologist, she is head of research at the Johann Jacobs Museum and currently Fellow at the Hamburg Institute of Advanced Study (HIAS). She has been visiting professor for Theory of Design at the Berlin University of the Arts (UdK) between 2018-2020. Her research focuses on practices of perception, theory of exhibition and the global entanglement of social and material forms.

Maarten Vanden Eynde is a visual artist and co-founder of the artist run initiative Enough Room for Space. His practice is embedded in long term research projects that focus on numerous subjects of social and political relevance such as post-industrialism, capitalism and ecology. Since 2020 he is a PhD candidate at the UiB / University of Bergen in Norway focusing on material traces that could represent human presence on Earth in the far future.

*All photos provided by the author.

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From Tale to Tail: Unwinding the Twisted Life Story of *PIG 05049*

A Conversation with Christien Meindertsma

Maarten Vanden Eynde

Keywords: animal welfare, bio-industry, pigs, globalisation, food chain, design journalism, product design, memory, remembering

Abstract: *Pig 05049* is a book and research project by Dutch designer Christien Meindertsma that chronicles the many consumer products that were made from a pig called 05049. The book offers an insightful look into how this one animal, a single source, provides raw material for a vast number of everyday objects. Meindertsma's clinical presentation of each laboriously researched object, page by page, organised by body part, follows the progress of the dissection of *Pig 05049* and the subsequent use of each part. Some products, she found, are expected and familiar, whilst other diverge dramatically: ammunition, medicine, photo paper, cigarettes, conditioner, and bio diesel. *PIG 05049* is currently in its 5th edition. The book won the Dutch Design Award in 2008 and the Index award in 2009 in the category *Play*. The article is a lightly edited transcript of a conversation between Commodity Frontiers editor, Maarten Vanden Eynde and Christien Meinderstma in September 2021.

Maarten Vanden Eynde: Thank you very much Christine for giving me your time to participate in this conversation. We are mainly going to talk about PIG, a project you produced already in 2007. At the time of the release of your publication I was still living in the Netherlands, and I remember reading in the newspaper that there were more pigs living in the Netherlands than people. I remember being very surprised about this but in retrospect it's strange because why wouldn't there be more pigs? Does it have something to do with the human tendency to put ourselves on top and this human arrogance to call ourselves homo sapiens sapiens, the double wise man? We named an entire geologic era, the Anthropocene, to human presence on earth, so maybe it has to do with that, but otherwise I think most animals are out numbering humans. In total there are at least 100 times more pigs than humans on the planet. So, I was just wondering if it has something to do with human nature that we want to dominate other species.

Christien Meindertsma: Yes, I understand your reasoning, but I think in this context for me personally it is a little bit different. The reason I find it odd is that we never see them even though they out number us. That is what is strange, that there are so many pigs and a very big industry, but they are invisible. Also, the massive number of pigs is not a wild representation of the species, but reflects those being kept as a product even though they are very close to humans and very intelligent. For example, the heart valve of a pig you can use as your own valve. They are raised in such closed systems and the only time you see a pig is when they are on a truck. Or at least the only time I see those pigs is when they are on their way to the slaughterhouse and you see their ears sticking out whilst you drive on the highway. It's so sad because it is their only time outside. So personally, I think that is what is very strange. The idea that you speak about placing ourselves on top of the ladder is not to do with the numbers of the pig but more for the fact that we think we can dominate them as if they are products and this is such a strange normality that we decided on in society. Of course, there are people arguing against this, vegetarians, and vegans, but most people are caught up in this chain system and conform to this as normality, when it is completely anything but normal.

MVE: I totally agree, and then you would expect that because we know about this that when the pig is made visible again through the likes of your work and animal rights activist who visualise these conditions that the animal endures that this would change our behaviour, but it seems we remain uncaring. It's like the blood minerals of which we all know now that they are part of our smartphones, but that doesn't change our behaviour to technology. Similarly, with fossil fuels we know that it causes global warming, but we continue to drive cars and fly planes. What creates this numbness that although we know that we are mistreating animals and effecting our planet, why can't we make this shift towards change?

CM: I think about this a lot, I think it depends a little bit on the subject. I do eat meat but very little, I am not against eating animals. I think if we consume a small quantity of meat, pay a fair price, along with treating the animal well it could be possible. Yeah, I do drive a car, but I only fly when it is really necessary for work and that means I haven't been on a plane in two years which I think is great. These are personally easy things for me to go without because I don't care for flying and if there was no meat, I would be ok without it. But for instance my car is quite important for me as it enables me to work on a personal level with a lot of people because I can visit them easily as they are often in complicated remote locations. So being without a car would hurt. I think everyone has their own personal relationship to processes that they can't be without and methods they can let go of. But then with the Corona Virus I find it so interesting to think about Schiphol airport during these last few years. Whenever I was there I though about how crazy it was, all these people that are there all the time flying. But now people are not there anymore, and you see that it is possible to not fly. What people missed the most was job availability and not seeing others, but not this crazy flying that we used to do. So, I think that's an interesting thought that a virus can completely and so quickly change our behaviour in a way that we never thought was possible.

MVE: This was however a forced change in our behaviour. We didn't decide ourselves, knowing the implications of flying, that we should start to fly less. This virus came in and completely created a wall in front of us, showing that we couldn't continue.

CM: Yes, it shows that we can make enormous shifts with lots of people that we never thought were possible. In this case I think it could be super inspiring if we all decided together to eat meat once a week and we could collectively make the change. It would be so easy and have the results that we want.

MVE: So why can't we or why don't we? We know that this would be one of the easiest solutions for a lot of problems related to the meat industry.

CM: It's clear that it is a difficult question. What people say in surveys is not corresponding with the decisions that people make in the store.

MVE: Did it change for you? It's been almost fifteen years after the book, did this change your behaviour towards meat, and also towards wanting to know what is inside any product? Are you more conscious of ingredients and where they come from?

CM: Yes definitively, all my work is about that. In my daily life I'm a normal person with a family. Before I had children it was much easier to not shop at a store or ignore things. Now, with children, when you decide that you don't want to have a large mountain of plastic in the house it not that easy anymore. It just kind of happens. You are a part of the fabrication of daily life, and I would love to be more meticulous about it, but then I would need to work less because it's a serious task if you want to get away from the system of normal shopping. You have to make a serious lifestyle twist to change that.
But in my work life it is different. After the pig book I was quite sad about this pig story and so I decided to do a similar project but then with a material that I wanted to support instead of move against and so I made a

project with flax, the crop linen is made with mainly in Belgium and the Netherlands and that was very nice. It was a similar project but moved in another direction. Linen and flax are really a topic and material that people are choosing to work with and it's great to see. I am diving deeper into these sorts of elements, so it is similar to the pig book but now more towards the general system, now I am more interested to explore the longer chain of production. To see how a product changes from one thing to another and how this cycle works. I think the pig book is very much a part of my way of working but I don't really enjoy repeating myself so I wouldn't want to make a similar project about another animal, like a chicken.

MVE: I was thinking about whether a pig in that sense is more special or more used in different ways than a chicken for instance. Is it something particular about the pig that means there are so many possibilities of pig products? Or could you do the same thing with a chicken?

CM: Yes, you could. The first idea was to follow a cow but then with some logical reasoning along with the advice from a woman working in the meat industry, we concluded working with the pig as the subject would allow for a broader product range. Cows are used less as they suffered from the mad cows disease at that time, so the gelatine from cows was not used, therefore influencing fewer products. I thought the subject of a pig was interesting because you rarely see a pig in the landscape, but you are often able to see the cuddly looking cow in the field. Pigs are also very unloved, there is a culture that thinks they are a very unclean animal. Also, pigs are really close to humans, so there are a lot of reasons why they are interesting. I think a chicken would probably have less uses but would be super interesting as well. I would love to do a project around chickens but then I wouldn't make a book. It would be a different kind of outcome.

MVE: There are many more chickens than pigs (250 billion chickens worldwide) making chicken bones one of the possible leftovers to serve as a geologic marker that marks a

transition between the Holocene into the Anthropocene. I found it shocking that they are so present all around the world that they will remain in the geological layer that we are constructing. But the other thing that I found very interesting is that pigs are so much closer to humans than cows or chickens. Now you already mentioned the heart valve and what I also understood is that scientists breed organs in pigs that can then be used for human transplants because they are so close to us. So, it is again another kind of astonishment, why don't we treat them better because they are so closely connected to us and indeed super smart? And recently there was the victorious Urgenda lawcase, the first time a government (The Netherlands) was held accountable for a lack of action against climate change. Something had to be done. There were many different options on how to immediately lower methane and nitrogen output and the first idea was to look at animals, and have less of them. However, the protest against this was so severe that in the end the Dutch government opted for a construction stop of buildings and they lowered the maximum speed on the highways to 100 just to make sure they could keep the same number of animals. So I wondered how they can prefer the option of reducing buildings and driving speed instead of having less animals or better conditions for them to live in. It seems so strange. When confronted with the opportunity to do something about the number and quality of livestock, we don't.

CM: One of the things I find interesting is that a lot of farmers feel that their country is not proud of them, so they have these stickers that say 'Trots of de Boer' (Proud of the Farmer) and whenever I see it I think this is very sad that they have these stickers. They need to almost shout at us to be proud of them because they are making our food. As a general reflection we aren't aware that we are paying too little money for the work that the farmers are doing, and we are defiantly paying a lot less than we were paying fifty years ago. On the other hand, they are also caught in a system that is so efficient they must continue to make these large productions to survive and thus become hostage in this system. I think every farmer would love to produce less for more money, but they somehow don't have the power to tell the system to be proud of them and that the money isn't the main issue. Even though it should be about the money because we should be paying more. This is a very interesting scenario in a conversation that we are not having together as a society.

MVE: Maybe that has something to do with globalisation because we used to pay more as the accessibility was less. It was more difficult to have pigs come from China which is where most pigs are now coming from. In order for local farmers to be competitive the government is subsidising farms to a level that is also not sustainable because it is then also too expensive.

CM: We are all caught in this complicated web where the rules of the game are changed because it is a global game and there are subsidies. This was why I tried to make the book as neutral as possible in terms of its opinion. If you choose sides within the layers of the story you also flatten the story. Of course, I am not always agreeing on how people interpret the book because it can be read in many different ways. One perspective could be that its positive that the pig is used for many different products, or you can think that it is horrible that the pig is in all these products that we use. Everyone who makes a different product in the book has a different story and I think looking back I am glad that it is as neutral as possible because I didn't want to condense a story that has so many perspectives and angels to it.

MVE: In that sense it is generous to leave it up to the reader to draw their own conclusion whether the use of a pig for a product is ethically, morally good, or not. I saw the book as a kind of monument, describing in a very neutral way what is made from the pig, a monument for the both the pig and strangely enough also the humans because we managed to make all this products. It made me think that we are successfully using every part of a pig which is also something we have always done as humans, to use an animal to its fullest capacity. We haven't changed much in how we deal with an animal so it has exactly this double feeling of goodness that we use every part of the animal but then on the other hand it is really cruel. A nice thing is that it also makes the same analogy as the book does: the pig is also shouting "be proud of me," look at what I am allowing you to make from me.

Perhaps in that sense your book is the bumper sticker of the pig saying "be proud of me."

CM: This is why I find the farmers sticker 'Proud of the Farmer' conceptually so interesting. Someone is saying: be proud of me! It could almost take the form of a one sentence play: be proud of me for what I am doing. Personally, I think yes, I am very proud of you farmers but are they proud of the person who makes their clothes or any of the other products you may own? Farmers are equally caught up in this commodity system and there is this same level of questioning the amount of respect we have for workers. Can a farmer also be proud of the person who comes to deliver a cardboard package who is equally not paid in a fair way or who doesn't have fixed working hours? It is through this 'Proud of the Farmer' sticker that I have all these thoughts. Ok, we should be proud of you for making the food but are we equally as proud of the underpaid delivery driver? It reflects on a much larger problem around products and production and what we pay for them. I understand them but they are as guilty as we are with the other professions that work in production which in turn makes it so difficult to solve. If it was easy to solve for the farmer, the model could be translated to other professions where products are produced. There are farmers in Holland, many people who are trying to change their way of farming, many people who are willing and enthusiastic to have farms that are more circular where all the crops and animals are in a balanced system the way it should be. But they are confronted with the issue that banks don't want to lend money for these alternative systems. So even when you are a farmer, and you want to try and make a change it is really difficult.

MVE: Totally true. I remember being an early user of the Triodos Bank in the Netherlands, but still today in other countries like Belgium, Triodos exists only as a saving bank. The other banks won't allow for Triodos to use their cash machines and act on the same level as them because of the competition. As soon as you want to change something in the system, it fights back because ultimately it doesn't want to change.

CM: This is what makes it so difficult to initiate the change we were talking about in the beginning. But I don't want to be super negative about it because we can make really big changes. I am now working on a project around wool. Nearly all of it is being thrown away. There are companies that make synthetic insulation materials and they are vilifying the sheep, addressing them as being a very polluting animal. But the sheep is assisting in another way, by grazing the land. This lack of transparency of the true costs and benefits is used by opposing companies to only read into the calculations that they want to use for their argument. It is in the calculating system where this miss-information takes place. And the same with our farmers, they are all the time fighting with ministers over all these kinds of calculations that are bigger than we can understand which makes it then difficult to change.

MVE: So is that a project you are currently working on?

CM: Yes I returned to wool because I graduated with One Sheep Sweater eighteen years ago. It was always my dream to make an industrial or semi-industrial product from local sheep. Wool is deemed worthless and now eighteen years later the wool is still worthless, but the spirit of the times have changed and there are many people who are willing to invest on all different levels to think about ways not to throw away the sheep's wool. The city of Rotterdam has given me six thousand kilos of wool from the 'Rotterdam flock of sheep' that is grazing the city.

MVE: I didn't even know it existed, the 'Rotterdam flock' sounds great.

CM: Yes, it really is. When you drive over the Van Brienenoord Bridge of Rotterdam you can see the sheep standing there on the dike. The wool from these sheep was always thrown away and the shepherd decided to act and asked the city council if they had a plan to avoid throwing away this wool. A lot of people were asked if you were given this wool what would you do. I presented a plan and they said you can have it, go for it. It has now been one year since that point and the wool is being sent off to become all different types of sample products. It has been washed, combed, cleaned and separated into different

kinds of qualities. The highest quality will be donegal tweed which is the most beautiful tweed there is. The lowest quality will have plants growing on it. There will be uses for insulation, it will be a whole range of beautiful things that can be made from the sheep's fleece. It really feels like the crown on my work to receive this assignment. It is such a nice statement to make, and it is so nice not to be bound to the economics of it. We will calculate the prices of course, but it is not about that. It is about showing possibilities and then choosing one that can hopefully overrule the current system where the wool is just burnt. We need to invent a way to use this wool better than to burn it because it is not just the Rotterdam sheep's wool that is being burnt. There is so much wool being discarded in this way, it is so sad. The fact that it is still allowed for high class brands like Hermes and Channel to continue to burn their products so that the market value doesn't devalue, now that should be a crime. To shred a new product just because otherwise the market value goes down is just so disrespectful.

MVE: Oh yeah yeah yeah, and it reminds me of inbuilt obsolescence, something that started a while ago to make a product break down at a certain moment. I think that too should be a crime. But it's nice that you somehow shifted after the book with pigs to turn toward something positive showing good things you can make from something not being used, compared with looking at bad things that are being produced from something. It's as if you made a switch to positivity and change from stagnation and resignation.

CM: Yeah, it is also like the pig book in leaning towards journalism, design journalism, which is a nice way to research because I think you find out different things. For example, with the flax project because I had ten thousand kilos of flax, you find out very different things than if you just did research in language form. You see a totally different world. Then with the pig book it stayed very much research in language, and I think as a designer that seems too easy to describe something but not give a solution in your own practice. I am product designer, so to just

point at another product that I think isn't good enough is not enough. I should be the person trying to improve it, not just point at the person who I think is doing it wrong. So that is the feeling I had after the book, that even on a small scale, I would try to add something positive in a real situation, like baking a really nice bread.

Maarten Vanden Eynde is a visual artist and co-founder of the artist run initiative Enough Room for Space. His practice is embedded in long term research projects that focus on numerous subjects of social and political relevance such as post-industrialism, capitalism and ecology. Since 2020 he is a PhD candidate at the UiB / University of Bergen in Norway focusing on material traces that could represent human presence on Earth in the far future.

*All photos provided by Christien Meindertsma.

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Nuclear Waste Culture: Projecting the Past into the Invisible Deep Future

A Conversation with Ele Carpenter.

Maarten Vanden Eynde

Keywords: Nuclear Culture, Atomic Age, Anthropocene, Nuclear Decoloniality, Radioactive Waste, Uranium Mining, Nuclear Weapons, After Present, Golden Spike, Memory, Remembering, Forgetting

Abstract: The Nuclear Culture project of Ele Carpenter is the overarching title for her curatorial research into art and nuclear culture covering the full material trace of radioactive materials from uranium mining, energy and weapons production, decommissioning and waste. The curatorial process involves working closely with artists and a range of nuclear contexts, carrying out field research, commissioning new artworks, curating exhibitions and hosting roundtable discussions and symposia. The project started in 2011 when Carpenter was invited to talk about how artists might respond to submarine dismantling by the Submarine Dismantling Project Advisory Group (SDP-AG) who were advising the British Ministry of Defence on how to take apart and store their old laid up nuclear submarines, some of which still have their old reactors on board. This article is a conversation between Maarten Vanden Eynde and Ele Carpenter about the urgency of nuclear visibility and deep time responsibility of radioactive waste in a period of increasing insurmountability.

Maarten Vanden Eynde: How did your involvement in the Submarine project lead to your interest in radioactive waste?

Ele Carpenter: The SDP-AG discussion began as a strategic debate about the ethics of dismantling to make space for new build but was soon transformed into a debate about recycling and waste storage. Certain categories of materials, such as fuel rods, were simply emitted from the discussion because it was assumed that they would already be removed and safely stored prior to submarine dismantling. In this way, precedents are used to close down questions rather than open them up and sequences of material processes are isolated into separate work packages that could be looked at differently. The SDP-AG documents referred to the GDF – Geologic Disposal Facility for high-level waste, without any actual plan to build one in the UK. So just because something is policy doesn't actually mean it exists. And in parallel, when we're thinking about nuclear waste; just because it is out of sight, it doesn't mean it does *not* exist. This was the spark for the Nuclear Culture project.

MVE: Compared to other examples of waste, nuclear waste seems to be at the top of the waste pyramid as far as longevity. Did this play an important role in the decision making to determine the shift from the Holocene to the so called Anthropocene?

EC: Positioning radioactive waste as exceptional in terms of longevity is a complex claim, and really opens up the question of what constitutes waste, and within whose timeframe. Nuclear Physicists often explain that radioactive isotopes have a half-life, which means they do not actually last forever, their toxicity is not infinite because they are in a constant state of decay. Unlike elements such as mercury which are actually stable forever, and will lie in big underground waste pools until the end of time. But, and there are a lot of buts… radioactive isotopes easily

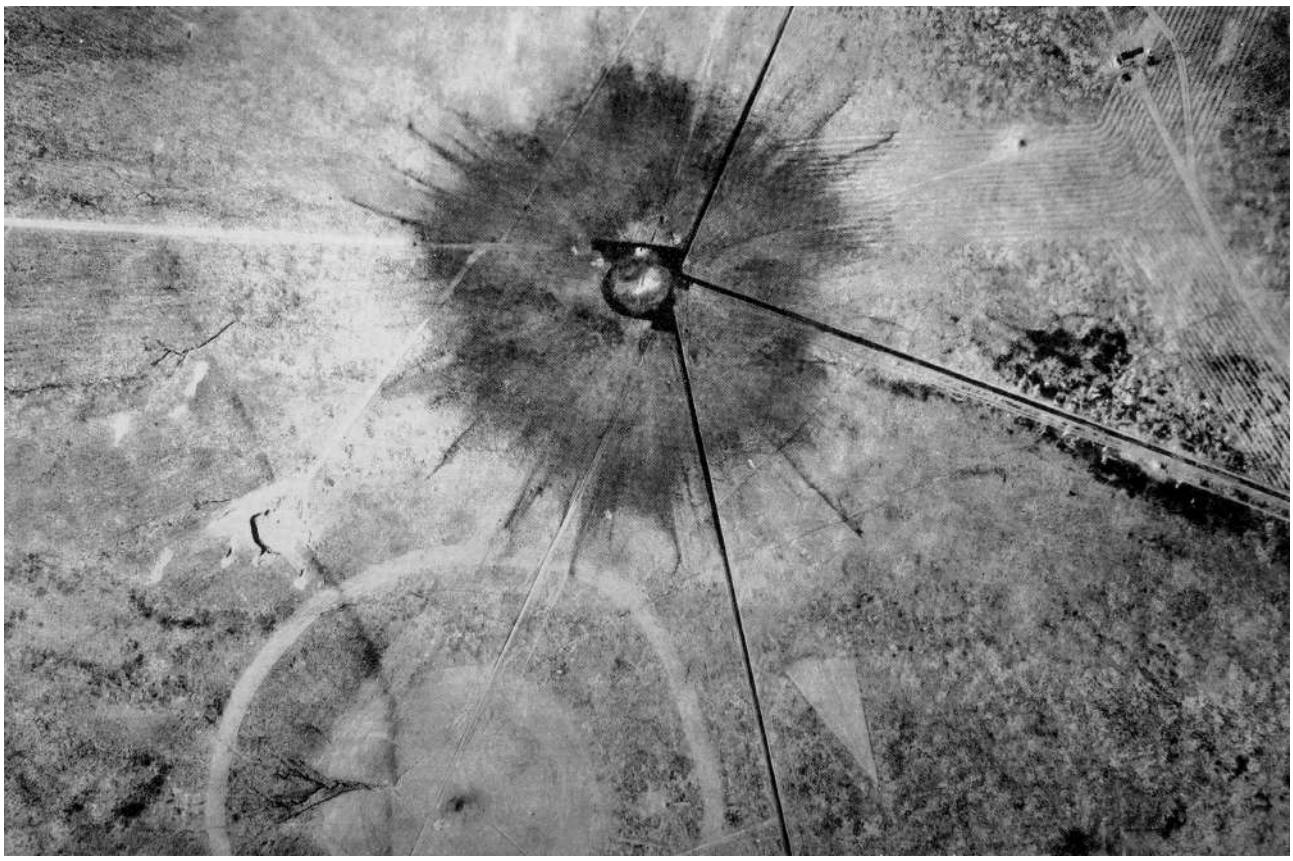
circulate in the biosphere through airborne dust and water, and are in danger of being inhaled and ingested, which is why they need to be contained and maintained for millions of years. I often argue that humans have a specific responsibility for their manmade radioactive isotopes which are produced through nuclear fission in a reactor. High-level long-lived isotopes are extremely dangerous for millions of years, which is 'forever' at the human scale. You can look up the half-life of any radioactive isotope, then remember that it needs to be isolated from the biosphere for ten times it's half-life (for example Plutonium 239, produced in reactors to make nuclear weapons, has a half-life of 24,100 years. This means that after 24,100 years it will only be half as radioactive as it is today, in 48,200 years it will be a quarter, etc). But this category of man-made or anthropogenic isotopes doesn't include Naturally Occurring Radioactive Materials (NORM) such as uranium and all her daughters, thorium etc, which can be dumped as tailings from mining operations without much nuclear regulation due to their NORM status (Hecht, 2012).

There are several classifications of radioactive waste: high-level, intermediate level and low-level waste produced by the nuclear industry, research and medicine. This is quite different from fallout from atomic explosions (Masco, 2015), and tailings from mining (Hecht, 2012). However, like radioactive waste both fallout and tailings cause contamination. Fallout is certainly a marker of the start of the Nuclear Anthropocene, with the first detonation in 1945, and peak testing in the mid-1960's which can be detected in mudflats around the world (Zalasiewicz, 2015). However radioactive waste is literally another layer, and will become a deeper geologic layer where anthropogenic isotopes are inserted into the fossil record in geologic disposal facilities (GDF). So we might consider fallout and geologic burial as two forms of evidence of human activity on the planet which are likely to outlive the human species.

MVE: In 2019, the Anthropocene Working Group (AWG) of which the before mentioned Jan Zalasiewicz is the Chair, voted in favor of submitting a formal proposal to the International Commission on Stratigraphy (ICS) to define the Anthropocene epoch in the geologic time scale. They proposed to locate potential stratigraphic markers, the so-called golden spike (GSSP) markers, in the mid-twentieth century. This time period also coincides with the start of the Great Acceleration and the Atomic Age. Is the start of Atomic Age, and maybe more precise, the detonation of the first atomic bomb called The Gadget, the right time and place to put the so called golden spike of the Anthropocene?

EC: The golden spike argument is a bit heroic, as if the vast and messy impact of humans can be defined in a single act, moment or marker. Reality is more enmeshed or entangled, and it makes more sense to map the networks of nuclear assemblages for which we need to take responsibility for today. This is certainly an aesthetic/ethical question about how we represent the nuclear age as an historical heritage problem, or a current condition of contamination combined with a renewed geopolitics of nuclear energy and weapons. Russia is clearly using the threat of nuclear weapons and the vulnerability of nuclear power plants in its war against Ukraine. At the same time their negligence of waste sites is a great cause for concern.

MVE: Yes I agree. Neatly stacking geologic strata on top of each other and generalizing conclusions relating to human representation, or even responsibility, is a tricky exercise which seems to be part of the history of science in general. Only by looking at the history of the term "prehistory" or "pre-literary history" for instance, which was used for the first time in 1836 (!) in the Foreign Quarterly Review for antiquarians in the UK, we know what can go wrong by defining and generalising categories. And history seems to repeat itself by the recent creation of the fault line between the new geologic time frame 'Before Present' or BP (also known as Before Physics, which is the new year zero and starts on January 1st 1950), and the undefined and speculative time frame that comes afterwards, the 'After Present' or AP. Is this another semantic way to avoid responsibility by a few for the dire and often long term consequences for the many? Or differently put, isn't long lasting waste like plastics, forever



Areal view of the explosion of first atomic bomb, nicknamed 'The Gadget' that was detonated at the Trinity Test Site near Alamogordo in New Mexico (US) on 16 July 1945.

chemicals, and for sure nuclear waste, per definition always someone else's problem?

EC: These time frames, or rather framings of time, create neat academic research packages, but negate continuity. Your question about waste being 'some-one else's problem' is interesting because the 'others' in this context are often indigenous people who are striving for the contemporary relevance of their culture to be understood. There are indigenous communities across the globe that have generations of experience of living with uranium mining and tailings, nuclear weapons testing, and contamination from nuclear research centers, who are now dealing with legacy waste as well as new waste storage proposals.

The temporality of responsibility is also important, where the some-one else is yet to come. So your question could be interpreted as waste will be a problem for 'future generations' if it is not dealt with today. And this is really the premise of the radioactive waste management argument for geologic storage of radioactive waste. GDF stands for Geologic Disposal Facility, but there's still a debate about the difference between storage and disposal. Storage enables continuous monitoring and responsibility. Whilst Disposal presumes that the safety case ends post-closure, and that the site will be safe forever. But GDF's aren't actually built yet, and high-level waste is highly problematic right now. Humans are still producing nuclear waste, so as soon as one GDF is open, the next one will need to be built. There are also many shorter-term storage sites (100-300 years) that need consideration. The point is that a 'deep time site-marker' might be a distraction from the multifarious layers of cultural responsibility that we need to explore today, rather than tomorrow. I think the way to communicate over deep time is to have a constructive way of communicating and listening right now. One of the most important impacts of the deep time marker debate is that it has engaged a younger generation of artists in thinking about nuclear culture. There are a lot of projects and ideas that are useful for understanding our contemporary cultural

radiological landscape which will have an influence on how we conceptualize the future. I hope that one day artists can be more involved in these kinds of humanities research project, but there's still an expectation that artists will visualize data, rather than interrogate the ethics of visual cultural processes.

MVE: Do you see a difference in attitude towards different kinds of waste within a colonial context in relation to disposal? Is nuclear waste an oddball, and if so in what way, or is the way it is being moved and dumped across international borders similar to other kinds of waste?

EC: I don't know much about other kinds of waste, so I can't really compare. But sadly the patterns of colonization are everywhere. Even the language used to classify different kinds of waste has a colonial dimension, where radioactive materials in the 'global north' have a 'nuclear' designation', but radioactive materials in the 'global south' do not. Gabrielle Hecht's book 'Being Nuclear' (2012) is all about when and where a radioactive material becomes designated and regulated as 'nuclear'. So firstly we have to rethink the terms of reference, and consider what is missing from international safeguards. Uranium extraction and nuclear testing are colonial projects that are simply not addressed by international nuclear regulation in the same way as the parts of the nuclear industry more typically located in the western/global north such as energy and weapons production. The European debates on radioactive waste do not include the historically unregulated colonial extraction and contamination of indigenous lands and communities. These processes are categorised outside of a Western definition of waste for very specific historical and colonial reasons, as Gabrielle Hecht describes in relation to South Africa. More research is needed into more conventional kinds of radioactive waste management and storage between countries. I've just finished a book chapter which addresses art and nuclear decoloniality (Carpenter, 2022), discussing projects by Lise Autogena in Greenland, Gabriella Hirst in Europe and Australia, and Alex Ressel and Kerri Meehan in Australia. My main argument is that we have to learn to negotiate radioactive contamination and the process of decolonization as ongoing, never-ending projects. There will not be a point at which colonization is resolved, or decontamination finished. I use Tuck and Yang's term of 'incommensurability' to describe the impossibility of white settlers solving these problems to absolve their own guilt. Of course we need scientific research on how to solve problems of toxic waste, but they need to acknowledge and work with other kinds of creative and indigenous cultural knowledge, the one that historians might call 'pre-historical knowledge'.

Attitudes towards radioactive waste have however changed enormously in the last 70 years. At the start of the nuclear age there was scant regard for nuclear safety, as Kate Brown (2013) carefully documents in her book *Plutopia*. Visit any nuclear site in Europe today and they will make a distinction between their 'legacy waste' inherited from a time when 'out of sight' was 'out of mind', and their ~~waste~~ management of recent waste where the regulators have a rough idea of what they are dealing with. The basic (European) premise regarding high level waste is that it shouldn't really be moved at all. However the UK offered international reprocessing of fuel rods at Sellafield for many years, and although the THORP reprocessing plant is now closed, they still have a backlog of waste to 'return' to countries such as Australia and Japan. I'm not very clear about the ethos of this waste-exchange, but it means that the UK is now trying to send intermediate waste to Australia (Tory Shepard, 2021). Radioactive waste is probably an odd-ball in that it is more regulated and more researched than many other kinds of waste. It has a high political profile, and governments are heavily investing in community consultation processes to try and site GDF's. The EU has a directive for countries to embed knowledge of waste sites within culture for millennia, and I don't think any other waste category has this much attention!

MVE: Indeed I think there is not any other waste material that sparked such a creative effort to think of ways to preserve knowledge about the dangers and contents of nuclear storage facilities. The proposals are manifold, ranging from massive monumental markers in the

landscape or obscuring and hiding it 'out of sight', to even religious cults making use of repetitive rituals of remembering. It confronts us with the fragile and insignificant nature of our existence. None of the cultural communication features of human society have endured long enough to safeguard information so it can still be 'read' or at least understood ten thousands of years in the future. Not a single language or graphic writing system, let alone a computer, survives that long. Maybe encoded messages in DNA strings could do the job. But how to communicate that this is the place to look? What solutions for this cultural conundrum did you come across that might give us the best chances of communicating with future generations?

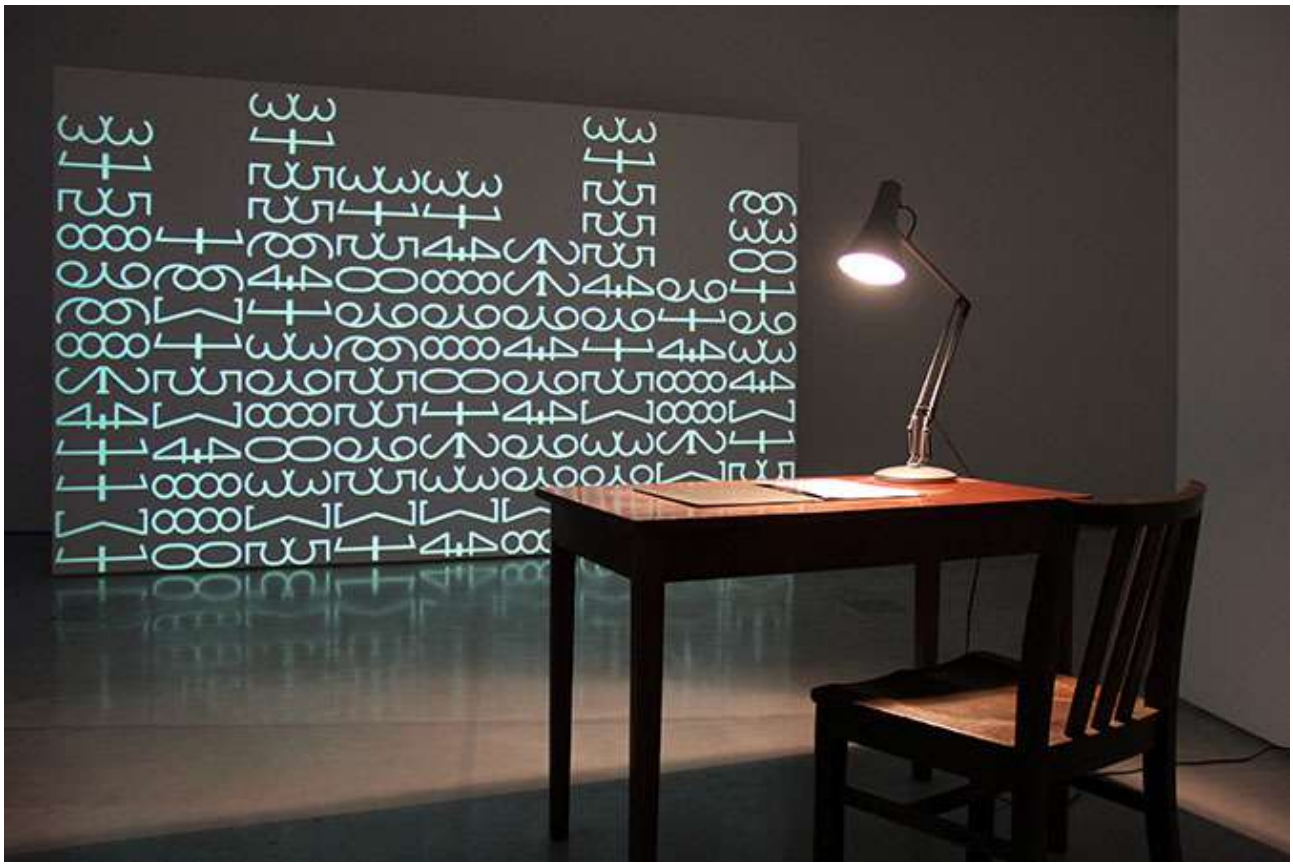
EC: Over the last five years I've been following Alex Ressell and Kerri Meehan's work with the local community in Gunbalanya in Arnhem Land, in the Northern Territories of Australia[1]. Here the aboriginal community have a continuous culture warning about the dangers of Sickness Country that goes back over 60,000 years. The rock art painting that tells the story of Sickness Country warns people against disturbing the land which will make them sick. The traditional Bulah Djang Coronation Hill paintings continue this warning, and have contemporary relevance right now. *Sickness Country* neatly outlines the landscape where uranium deposits lie close to the surface, and have been mined since the 1950s mostly against the wishes of the traditional land owners (Alex Ressel and Kerri Meehan, 2017). There is no 'before' or 'after' present in this environment; there is only before and after colonisation. The artwork continues to education future generations whilst uranium continues to decay for another 4.5 billion years.

Alex Ressell and Kerri Meehan, *Sickness Country, Photograph* (2017).

[1] Alex Ressel and Kerri Meehan, artists website available at <https://www.ar-km.com/> (last accessed 28 Feb 2022)

As we discuss in our new book chapter (Carpenter et al, 2022) Alex Ressel and Kerri Meehan's collaborative projects create and gather artworks that explore the role of intergenerational storytelling in the culturally rich uranium landscapes of the region. Working closely with the local Aboriginal community, the artists are learning to rethink the nuclear landscape in relation to Country, kin and temporality, drawing on 60,000 years of cultural knowledge. [2]

The radio artwork *Sickness Country* (2017) by Ressel and Meehan is a compilation of conversations with people in the region about how the contemporary ancient culture has developed knowledge about uranium, including a rock art painting that depicts a person sick with Miamia, with swollen joints from disturbing the land (see photo above)[3]. In the program notes, the artists explain that: "Sickness Country is an area within the Kakadu National Park that has been known as a sacred and dangerous place for thousands of years. According to ancient and living stories, disturbing the earth, taking rocks away, camping, harvesting crops or getting cut in Sickness Country could have grave consequences. In the 1950s, uranium prospectors looking for ore bodies in Australia's remote North found rich mineralizations close to the surface in areas of Kakadu".Throughout the program, the interviews move increasingly closer to the correlation between the warnings of Sickness Country and the uranium deposits just below the surface. Local people explain that mining only shifts the potency of uranium from one place to another, where it will eventually cause destruction, such as that seen in



Thomson & Craighead, *Temporary Index*. A temporary index is an array of decorative counters that mark sites of nuclear waste storage across the world. Each counter is a kind of totem marking the time in seconds that remains before these sites of entombed nuclear waste become safe again for humans. These timeframes range from as little as forty years or as much as one million years.

[2] Injalak Arts Centre website available at <https://injalak.com/> (last accessed 28 Feb 2022).

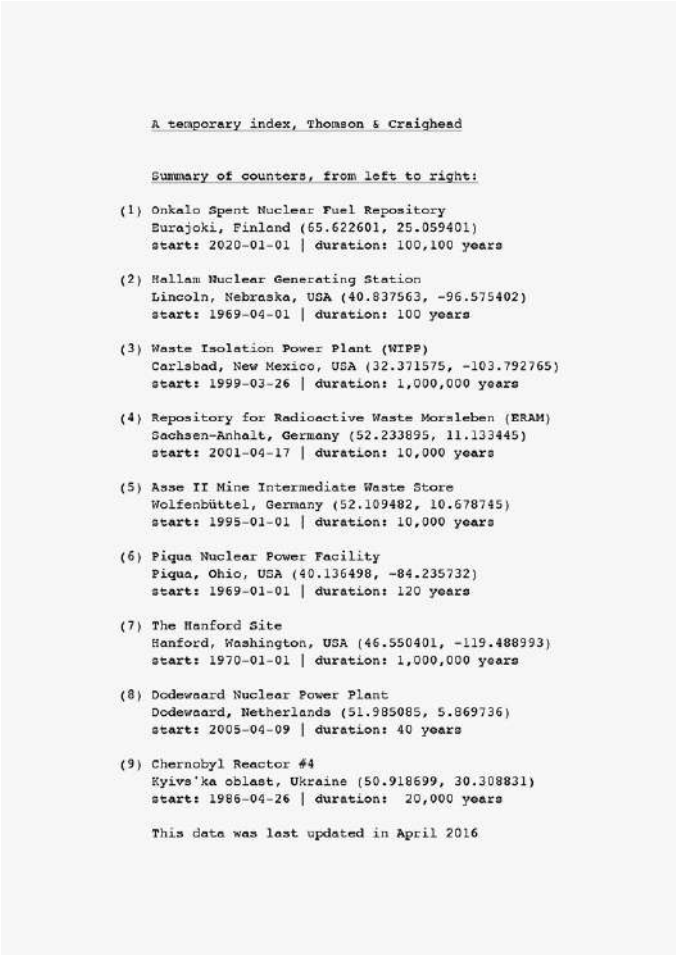
[3] *Sickness Country*, radio artwork, by Alex Ressel and Kerri Meehan, broadcast on Resonance 104.4FM, 18 October 2017, <https://www.ar-km.com/sicknessCountry.html https://www.ar-km.com/sicknessCountry.html> (last accessed 28 Feb 2022).

Fukushima. This trace maps response-ability, shifting away from the language of the global industry of extraction to an awareness of ecological connectivity. So that telling these stories becomes an awareness of planetary nuclearity. Uranium extraction is rarely included in the nuclear discourses of the global north, and these works seek to make visible deep-time material traces along with the knowledge of the landscape passed on through generations.

I'm also thinking of semiotician Thomas Sebeok's (1984) concept *Atomic Priesthood*, beautifully enacted by Robert Williams and Bryan McGovern Wilson in their Cumbrian Alchemy project (2013). The artists' wider project investigates how knowledge of the past is embedded in the landscape, language and place names in Cumbria, weaving together the recent nuclear history of the region with its Norse history. There are encoded messages everywhere but we have to have the time, cultural knowledge and frameworks to be able to read them. Our experience of place is so mediated through data, you need to be present in a place both physically and digitally to be able to read it. Digital spatial mapping presents another set of challenges, which have yet to be fully explored.

The *Safe Cast* citizen science project for communities to monitor their own radiation levels is another good example. Crowd-sourced data collection might be one of the most effective forms of communicating with future generations because of the critical mass of people involved, and the distributed data collection. Everyone needs to learn to use a Geiger counter, and everyone needs to know some basic radiation protection safety. The Covid-19 pandemic has raised awareness of virus protection, and people are fairly well-trained in UV protection these days, so why not radiation protection? Guarding against dust inhalation and ingestion is vital if there's a domestic or international release of radioactive isotopes.

And last but not least, as part of the Nuclear Culture project I worked with artists Jon Thomson and Alison Craighead on their *Temporary Index* artwork. The work is comprised



of an array of counters that mark sites of nuclear waste storage across the world. The artists explain that each counter marks the time in seconds that remains before these sites of entombed nuclear waste become safe again for humans. The live decay-rate counters, markers of time as well as place, are adapted to the specific sites in which they are shown, and can be presented as the whole array of counters, or as single totem clocks. The artwork has been a central counter in all the Nuclear Culture exhibitions where it has measured the temporality of the nearest radiological waste site or contamination risk.

In 2017-2019 Thomson & Craighead were commissioned by the Nuclear Decommissioning Agency (NDA) and High Life Highland to create a *Temporary Index* counter for Nucleus, the newly built Nuclear and Caithness Archive at Wick, Scotland. The Nucleus building is home to the archives of the UK civil nuclear industry and the historical archives of the county of Caithness. It is also 30km from the Dounreay nuclear site which is undergoing a 300-year decommissioning process. *Temporary Index* is a totemic object of contemplation providing a way for humans to

measure ourselves against the long atomic time frames recorded in the Nucleus Archives, which will be passed on from generation to generation. As far as I know the work still lacks a label which references the time period of the counter. This is because the NDA wants to prioritise cultural engagement with deep time of somewhere else, but is not always comfortable referring to the radiological activity of sites closer-to-hand. Their focus is on the waste management process rather than the longevity of the isotopes. As Sebeok intuited, perhaps the best way to communicate into the future is to listen to the past.

MVE: That is a beautiful way to end the conversation unless there is anything else you would like to add or ask?

EC: There's a lot of focus on remembering, but what about forgetting? Perhaps we also need to focus on how to forget? I love the counterfactual storytelling in McKenzie and Spinardi's (1995) paper on tacit knowledge and building nuclear weapons. It's exciting to think that humans might soon lose the knowledge to build nuclear weapons. However, the weapons themselves, and the vast military-industrial complex created to build them still needs to be dismantled and stored safely. Whatever the ethics of production, waste management is here to stay.

MVE: Thank you Ele, I'll try to remember to forget from time to time, and I'll make sure not to forget to remember for the rest of the time.

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*All photos provided by the author.

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Before I Forget: Learning To Live With A Dynamic Memory System
A Conversation with André Fenton

Maarten Vanden Eynde

Keywords: neuroscience, memory, remembering, forgetting, external memory devices, theory of mind, DNA, RNA, epigenetic, trans-generational trauma, dynamic system

Abstract: With the increasing availability of memory devices that supplement or in many cases surpass our biological memory, the question of where the body ends and the rest of the world begins becomes impossible to answer. With current AI technology able to retrieve text from brain scans of thinking (or transmitting?) people, are we slowly becoming part of a massive mind of many, rather than a collection of individual brains full of interacting neurons? And what concepts or language will we use to describe memory features in this transhumanist future? This article is an edited transcript of a conversation between *Commodity Frontiers* editor, Maarten Vanden Eynde, and neuroscientist, André Fenton, in April 2023.

Maarten Vanden Eynde (MVE): Let's start with two simple but related questions, focusing on our own body first, before zooming out: where is memory located in the human body? And how does it get stored?

André Fenton (AF): We have to be careful in order to answer that by defining memory. And there are many different ways to define memory, because we don't actually know what it is. From the most basic point of view, the most fundamental concept of memory is information storage, and that information usually comes from lived experiences. We wouldn't think of memory as something in the genetic code that is passed from one generation to another, or from one species to another, but that's certainly also information storage. It usually comes from an individual's lived experience, and information that is stored from that experience. People recognize memory because it changes what one does in the future. It has this ability to cause, whether for better or worse, changed behavior. That is the common way of thinking of memory.

Information storage must happen, at least in a biological way, somewhere in the body. We mostly think that information storage is guided by things like neurons, the primary type of electrical cell in a brain or central nervous system. Those neurons extend to the gut, they extend to muscles, everywhere, but they are most concentrated in the brain. We have studied memory as information storage in the brain, but it is very clear, super clear, that that process is happening in lots of places other than the brain. Like the spinal cord, as part of the central nervous system, but very similar processes are free to occur as well at the neuromuscular junction where neurons from the spinal cord contact muscles. The system is able to learn and store information from experience in lots of places.

If we continue to think about memory as a process that is the consequence of experience and causes information storage, well, you know from lived experience, that you can store information outside of your body in a device like this [André Fenton is holding up a smartphone in front of a camera of a computer on the other side of the world].

We can store information in our bodies with so to speak "devices." A trivial example that we

probably don't think about too often is our gut bacteria. My experience, what food I eat, how stressed I am, how not stressed I am, all these kinds of things have a consequence in me trying different types of diets and affecting the different times of day that I eat. I'm affecting my behavior, which changes my gut biota, making it different today than it was last year when my behaviors were also different. This is a lasting consequence of my behavior, and now I have to live with it. I might not consciously access that behavior, but it's nonetheless information storage that I persist with.

To answer the question in that context: for the kind of memories that we consciously recall with a fair bit of ease, so-called "content addressable memory," the brain is very clearly the repository of such kinds of information. But memory as a process is distributed way beyond the brain and the interactions of the brain with other physical parts of the body that are not central nervous system organs, but are the interactions with those organs. It's not an intellectual leap to jump to an external storage device and it is relatively easy to see how we have a continuum of quantitatively different storage devices that are distributed on paper and books, in collective consciousness, and laws, and so on.

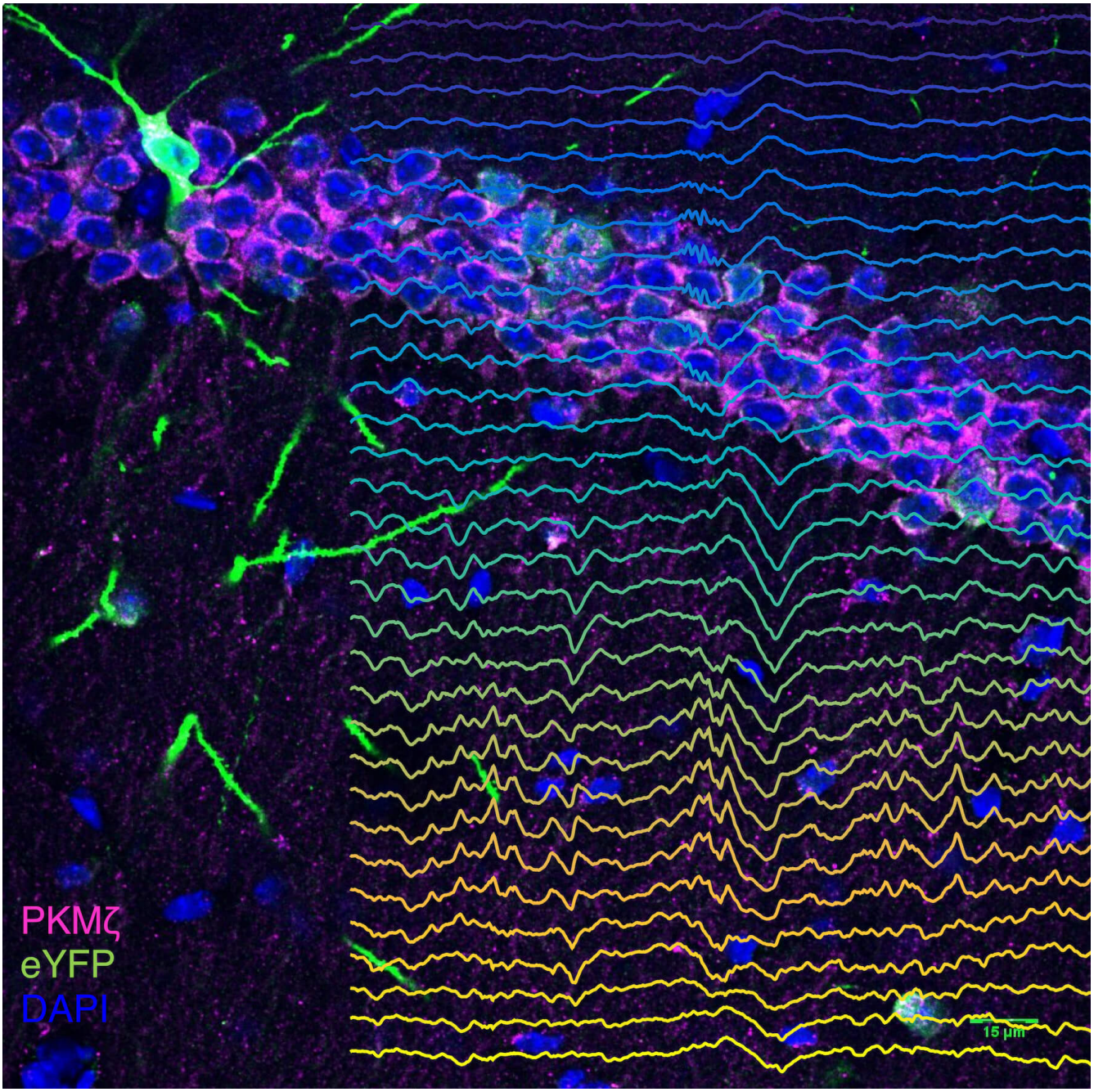
MVE: We will touch upon external memory devices or techniques a little bit later, but now that we looked at the *where*, let's briefly look at the *how*. How does this information storage happen? How does it become a retrievable memory? And how reliable is it?

AF: How memories are stored is again not known. There are two ways to think about memory and therefore memory storage, although it's the same process I will describe. What we believe—but are not certain about—is that to store information and memory, you have to make a physical change somehow, and that change has to be enduring. It is not easy to store information, for example in water molecules. Some may claim it can happen, but it is very hard to imagine because water molecules have a particular arrangement; they seem to move randomly, so it is hard to show that the water is different from one time to another.

Most memory storage mechanisms show an enduring change, and what's intriguing about the ways we think about memory storage in external devices, is that those changes are enduring for a long time. We make an electrical change or a magnetic change, or ink on paper, or a chiseled imprint on a piece of stone, whatever that is, and you can go and see reliably that it is still there. The paper may fade, the ink may fade or smudge, but there is evidence that there is difference and that those differences are enduring. So how does that happen in biology?

What is particularly curious in biology is that the elements that are changing are the elements that are *not* enduring, like proteins. Proteins are the output of using the genetic code in order to make something. The genetic code is mostly a set of instructions to make proteins. If you think about the process, the genetic code, the DNA [deoxyribonucleic acid] is a very stable molecule that endures. You can go and find dinosaur DNA in principle, but to turn DNA into protein is a very fragile process. You have to copy the DNA to make something called RNA [ribonucleic acid]. That RNA only lasts hours— not days but only hours—and those RNA have the instructions to make proteins, and the proteins last days, not years. So now you have a fundamental problem since most people's memories last decades, soon to be centuries. They are persisting for decades, but they are made from elements that only last days. How can you actually do something like that?

Think of the *Ship of Theseus paradox* where you, even though all of the elements are replaced over time, still have the same ship. The key is not to take apart the ship entirely at any one moment, but to replace each piece, little by little, and then you can have an enduring process as long as you accept that it is dynamic and all the parts are exchangeable. If they exchange at a fast rate compared to the half-life or durability of the object itself, you can have something perpetuate with fragile elements that will maintain. This is the job of chemistry. We know if you put two things together and they



"Structure of Cognition" Immunohistochemisty for the memory molecule PKMzeta in memory-expressing cells (EYFP) in a mouse dorsal hippocampal brain slice, with color-coded overlay of local field potential traces recorded from a 32-site electrode. (© Edith Lesburgueres and André Fenton)

happen to have an affinity for each other, then they will tend to accumulate together. If you put a bunch of people together who are randomly not associated to each other, they tend to congregate in social groups and because of that, you find that there are social groups that tend to endure and they don't even depend on the individuals. A university is a really good example, a nation, a neighborhood, so on.

These things don't persist in a pure form, they change slowly over time, while their individual elements are turning over much faster.

The way we think about memory storage is that you need a process like that, at least to the extent that we know. I mentioned from the outset that there is at least one other way to think about memory that's not so much in the

information that is stored—although that is the ordinary way we think about it—but we also know that in storing that information, we actually change. A good example of this is that I am a professor at a university, and what does the university do? It teaches you. You are supposed to learn at the university, but what are you really learning? Are you just learning information, are you just storing information? Hopefully not. Hopefully whatever you are learning is going to change your mind, change how you will behave in the future because of that learning. We call this an education.

This information storage is not being written down in something external—and that is the really interesting thing about biological memory —it is being written down in the same system that had the experience in the first place. That system is now irreversibly transformed to a new system, or at least a different system, that can experience the next opportunities of experience. From this point of view, the "how" of memory storage is very interesting because this persistent and enduring set of changes provides opportunities for tweaking, integrating, and adjusting what was stored. That has really important consequences because you are not merely a storage device; you are a self-organizing device that uses storage to process information.

MVE: Would it then be fair to say that when we both revisit or don't revisit a lived experience that the memory of it will always change? Because it has been processed constantly and the limited longevity of the original proteins that contain it are fading away so fast that we constantly need to produce new proteins that will remember it differently?

AF: Yes, it works like this, but let's not blame the proteins. It's not the protein's fault! The proteins and the proteins' process very interestingly have the chance to persist like the *Ship of Theseus*. But the fact that this turnover is perpetual provides an opportunity that your "external memory device" usually doesn't have. It's an opportunity to adjust what you have stored, for good or ill, but according to the current circumstances.

I find this very empowering, others find it disturbing, to recognize that I have the ability today to revisit my past and understand it and even remember it differently than I had experienced it. I have that ability, and that's because integral to my abilities to remember are my abilities to process information and to imagine my future and to understand my past, from my current vantage point. This isn't because of the protein, it's the opportunity that having a dynamically persistent mechanism offers you. It is very hard to do that when you have chiseled your mark onto a stone that doesn't have a dynamic life. It's very hard to adjust that, it's much easier to get a new stone and chisel something else.

MVE: I see, and maybe that connects to what I wanted to ask about when you previously said that memory comes about due to an experience that you have and not necessarily one that your parents or grandparents had. This kind of information is also stored genetically and even your distaste for some foods when it is stored in the gut biota. These genomes are inherited so you might revisit and relive certain experiences your parents or grandparents had?

AF: People are now studying trans-generational memory, trans-generational changes that happen, and the evidence is very clear that it happens. It happens through epigenetic changes, it can happen through "external memory devices" called bacteria that live in us, and so on. And remember, memory is a concept. None of us know what memory is. Plato contemplated memory, but Plato's ideas of memory are not my ideas of memory, and neither of us is wrong. These are concepts that have evolved as we learn about the world and ourselves and the mechanisms.

MVE: That is the same as the mind in that sense, to introduce the concept of mind. It's a very elusive concept that everyone is right about because nobody knows. When I started to read more and more about the brain and the mind and the difference between them, I was wondering whether there is something that exists outside of the human body that stores information—or experience if you want— and that does not disappear. I like very much the

idea that the mind is something we always offload information and experiences on, and that, as a culture, a community, or a group, we can carry it with us as we move forward, so that it is something that stays alive even when we die. During my lifetime I add to that larger mind, which is not just my own. I wanted to know what your ideas are about the difference between mind and brain and whether the mind is something external to the human body?

AF: These are very deep and unanswered questions, I think, so let's start with an analogy. If I describe to you a wave, we could talk of an ocean wave, a light wave, sound wave, it doesn't really matter. We can recognize that wave, but it is very hard to recognize the wave and describe the wave without having a medium for the wave. The wave is not the water, but you need water in order to have an ocean wave. The wave is not the air molecules, but you need the air molecules in order to have a sound wave. All that proves that we are very familiar with certain properties that emerge from other things, and those things are physical things of matter and energy. I can weigh a brain, I can tell you if it is fat or skinny, normal or abnormal in terms of its shape and parts and such. But that isn't mind. I believe we need a brain in order to observe mind, because mind is something that emerges from the operations of that brain.

Brains don't operate in isolation they operate with muscles, they operate as we now learn with biome, they operate between brains that are interpersonal operations. We are doing one now for instance. I am using my brain for that and your brain is changing because of that. The way you hold your posture is being registered through my vision and through my vision my brain is adjusting to that. We are changing each other and our brain activity as we do what we are currently doing.

So where does mind come in? It emerges from this in some way, so it is very difficult to separate, and given what we know today, it may be unwise to look for the distinctions between brain and mind and recognize that these are not interchangeable concepts but one must emerge from the properties of the other. Very likely the causal arrow is going in both directions.

One of the things I think is not commonly taught, but most physicists and certainly modern biologists are very comfortable with having, is a system that we can be described as dynamic. Dynamical systems are fundamentally changing systems that at the same time stay stable. So, if you are fundamentally changing but at the same time you have stable regimes—well we are very comfortable with describing systems like this—they come to some equilibrium. Systems tend to stay stationary even though they are undergoing change because of these equilibrium states. So you can imagine then that there is an interesting interaction between the products of brain which would include mind, which would include behavior and communication, feeding back to cause the brain to also absorb those consequences we call experiences, and make changes. In a sense, we have created the concept of a mind as if it is separate from the brain, but it is actually integral to the brain. And once you realize that, you start to recognize and get back to where your question started. You get to realize that minds have a set of consequences outside of the brain that are very hard to separate from the brain.

To summarize: it's a matter of degree, I would argue, where you draw the line between the realm of the mind and the realm of the brain. And again another matter of degree where we say we are in the realm of mind and society or culture. How all of these connections occur across beings, people, groups of people, and even to my dog. We also communicate and share, and we do it exceptionally well between me and my dog compared to other dogs or to the rabbit that I had when I was a child. All of these things are a matter of degree from one point of view and a lot of it comes from us not really understanding how you get from one state of being to another state.

MVE: This connects to the concept of the zero-sum game, something that when we first met in New York resonated most after our conversation. This is the idea that you have a certain amount of information or storage capability and in order to remember something new or have new experiences, when your storage capacity is full, you need to override

older ones. For the brain, I can kind of get my head around it (no pun intended). But, for the mind, I was wondering if it can only exist in my idea of it as something that can grow almost infinitely because it is being fueled by so many, and increasingly more human brains that add experiences to that mind. How does that work? As you say, we have an interaction, our minds are connected, but when I pass away, my brain would go away although that experience would still be "in the mind" because you are still there. Your brain keeps the memory of our encounter alive. I was wondering if the concept of a zero-sum game can be extrapolated on the mind. Can it be "full" at some point and is it doomed to overwrite previous offloaded experiences if it wants to store new ones?

AF: We have to be careful about a zero-sum game as it just means a conservation, if you will. It doesn't mean that when you have arranged the parts, that you have it in an optimal way, so you can, by rearranging the elements of a brain, optimize that brain for having enormous storage capacity without actually having to get another brain. A really good analogy that I like is to think about the computer that we have here. It's incredibly powerful, it uses an enormous amount of memory, and almost everything it does, you could do with endless amounts of memory. But you don't have to do it, you don't have to write efficient code. You can write code that is very inefficient but is easy to transform and share. If you had memory limits, if the technology limited the amount of memory we had, we could accomplish the same functions, it might take longer, it would take planning, it would take building a whole new code base every time you had an insight into how a processor could work. But we don't have to do that, we can expand the memory limits by reorganizing what it is we transacted.

As an example, we have abandoned many concepts that we had in the ancient world or even 20 or 30 years ago that we don't generally use because it turned out that they were wrong, inefficient, or misleading. I will give you a very powerful example: the idea of race.

Race is a concept, it is only a few hundred years old, we didn't have races, believe it or not, three/four hundred years ago. But we have that concept right now and it is structuring an enormous amount of what we do as humans. It is constraining and enabling from some points of view, whatever it is, it isn't neutral. And it is one of the most powerful concepts we have, but it has no foundation in the material world, no foundation in biology. People spent a lot of time assuming it would, but it has none, from as much scrutiny as we have been able to provide. The prediction is that in 100 years we will not have this concept anymore, and it will not occupy our mind or constrain or direct our minds, but we have to manage living with those concepts right now. Whether or not I believe the concept of race is going to change how I interact with another person, I can't hold the concept of race as being absolutely false and immaterial and also something that is potentially valid and real and interact with you in a way that is independent of those two ideas. I have to pick one or the other. I chose that as an example because I think it is a very powerful example, but we could choose hundreds of concepts.

MVE: Another is gender for example. The perceived or learned differences between gender has such a big influence too, until today, and probably didn't exist in the past and hopefully will not exist in the future.

AF: That's right, this is the next one I would say, and people think of these as fundamental things. The supreme court in the US is very concerned about this, but these are just ideas and they evolve.

MVE: I agree, and the same goes for national borders or nation-states, all of these things are just concepts and they change constantly too, although some faster than others… I would like to go back to external memory storage and make a link with the role of art in the history and evolution of external memory devices. Within my doctoral research, I am looking at art as the first example of representational abstraction. The oldest abstract drawing and the first symbolic scratches on a piece of ochre were found in Blombos cave in South Africa

and date back about 100,000 years. It is clear that the lines meant something—we don't know what, and we will probably never be able to figure out what they stood for and how they were used—but we know they were not random or accidental. I believe that that was the initial role of art: to function as a facilitator to create representational abstraction outside of the human body, and by doing so, allowing us to enhance our storing capabilities. Do you think art can be considered the earliest memory device, the earliest example of the externalization of memory?

AF: It certainly feels that way, depending on what you want to say came first, but you might consider in the expanded view that I think I have professed, and you might not make a very big distinction between what you might call art and what you might call a tool.

MVE: Sure, the tool as artefact.

AF: The tool also has these features. The artist or the toolmaker, somebody has taken their understanding of something, the understanding is typically very rich, and they have compressed that understanding into a set of principles, or a set of most informative features. Extracting the facets that are most informative that's what the artist, toolmaker, communicator, needs to do. We call that abstraction because I don't know how to take the richness that I have in my head and put it in the world. I have to find out by abstracting what is essential and I will attempt to make that communication through art, or a tool. This allows me to do something, to show someone else something, it allows me to embody the thing that I had so that I can observe it.

I like very much the idea that in neuroscience we are studying things that we cannot see, and that we cannot experience directly, and so we don't make art, but diagrams, cartoons, animations, models of these ideas we have that are partially observed. But more important than how they are observed is how we conceive of them. We do this to show them to other people, and "the other people" that I do this for, mostly, is myself. If I can put it on paper or in a form that I can now observe, I can recognize what I abstracted and whether the abstraction was effective or not. For example, you can observe and see that there is another piece that is essential and I forgot and so I can put it down. I am able to understand it that way, so yes you can imagine this as a way to communicate from one brain to another, but it is also a way for me to communicate with myself; to think, if you will, out loud…

MVE: … and revisit a concept that you put down on paper that is now liberating space for other concepts, and you can revisit it and look at it and understand it again.

AF: That's right, and the goal is not to represent a thing as it is. I think we falsely understood it that way. But the goal is to represent my understanding of a thing that I have; the goal is abstraction.

MVE: Yes, and I think the only way of doing that is through repetition and it doesn't matter how many different media we invent, we will always have to have repetition that comes along because when I talked about the first abstract drawing and the symbolic scratches, that was already a next step in the externalization process of memory. Art enabled abstraction, and art I would see as something very vast, including music, sound, rhythm, and movement, because these were the first steps in the externalization process where you still are in need of the body and it is very clearly related to repetition to externalize it. But even when you have something like a physical object that becomes part of the equation in which you make scratches and marks, you will still have to repeat it because without explaining the abstraction no one will understand it, probably not even yourself, maybe for a certain while. But if you don't revisit it from time to time, it will also escape your own understanding. So there is something super interesting about it, that whatever we invent as a technology to remember something outside of the human body, we still need the methodology of repetition and renewal to make sure that we understand the same thing. Otherwise, we don't know what letter and what sequence of letters has what meaning, and still then, the interpretation of that word changes over time.

Reproduction of a crosshatched drawing at Iziko Museums in Cape Town, scratched on a piece of ochre, excavated by SapienCE, Centre for Early Sapience Behaviour in Blombos cave, South Africa. Photo: Maarten Vanden Eynde, 2023.

Storage room or physical archive of SapienCE at Iziko Museums, Cape Town. Photo: Maarten Vanden Eynde, 2023.

AF: What you just described is what we talked about 40 minutes ago! This is biological memory! There is a deep reason, it's not the protein's fault, it is the opportunity, we do it no matter what. Anything that we try to do that is enduring we make it so that it is evolving and adaptive and allows us through the process of repetition to come to the process of understanding. I think many of us ordinarily confuse ourselves by believing that the goal is actually to capture something and have something not change, but no one wants this. Some people have exceptional memory capabilities and remember everything that happened to them in all of its detail, and this is considered a pathology. If you ask people with this specific condition of remembering if they are happy about their ability, they will say no, they are miserable for these abilities. Are these people high-functioning and can they do anything in the world? Typically not, because in the way humans have organized themselves, this is not a feature.

MVE: Indeed, it's rather continuous change, and if you don't change along, you will stay behind alone as the only one who knows exactly what happened but no one wants to talk with you.

AF: That's an astonishing fact and yet we want to praise memory and so on. Again, I think the challenge is that our ordinary concepts of this are mistaken. They have not embraced the notion that information should not stagnate, that information should change, and the reason it should change is because you interact with it. By that interaction, it changes and it changes you, and it is good that this happens. This is where we actually live, this is where we grow, this is where we refine, this is how we communicate, this is how we improve. Trying to keep something stagnant that is fundamentally dynamic costs enormous amounts of energy and is misguided.

MVE: To continue the thought of constant change, I was wondering what new words or concepts will be invented in the future to talk about memory storage, because it seems that throughout history we have always used concepts related to current technology to describe how our memory works. Think of uploading, processing, and reformatting information in the current computer age. With memory being written on DNA and data storage becoming biological, what kinds of words would we use for this technology? What if we were able to store information not on a device outside the biological body, but on something that can be implanted and thus internalized again as a brain supplement to enhance our memory from the inside? Since you are closest to that new evolution, maybe you can think of some concepts or words?

AF: I will give you a concept that you will not find people on the street nodding to: dynamical system. Memory is part of a dynamical system, and memory is stored inside the dynamics. What does that mean? I will use an analogy: you can arrange a bunch of people, you put them together, you give them an economy, places to live, and so on. And so now you have a structure that is evolving but also stable: it is called a city or neighborhood. There are certain elements of that neighborhood that are guiding infrastructure. People will tend to pass on certain paths and particular roads, but not others. Shops and places for commons will follow that traffic, and places of recreation will follow other routes.

If you go to your neighborhood park, whoever designed it designed it with certain walkways. Out of convenience or whatever reason, humans typically go across the grass. They mat it down, and the next person comes and they question where they will go and they go the same way, and so this creates a path. These are the dynamics of the system and the information is getting stored in the dynamics that the architect didn't design. It then becomes the place to leave your wallet, the place to leave your cigarette butts, the place to carve your name on the tree. The dynamics actually provide the clay of old in which we can inscribe. When we use the clay and pen tablet as our concept of memory, we are now developing that, why?

Maarten Vanden Eynde, The Last Human (2017). Photo: Philippe De Gobert.

Because we are studying that, that's how I look at this, that's how I measure it, I am not measuring one protein, I am measuring hundreds of proteins interacting with each other, thousands of them are surely interacting but I only know about hundreds. When I talk about a neuron, I know that a million neurons are at least interacting and it is through the dynamics, the structure of their interactions, which neurons talk to each other and which neurons don't talk to each other. Like the structure of a social network that today many people are familiar with.

The idea of a network is a very old concept but most humans weren't familiar with it. But we are now, through social media, aware of the networks that we engage with, the human networks, so we can understand now how rapid information transfer can go, because of these networks. What is valuable about this experience—to the extent that I know and study memory—is it turns out we are studying memory with those concepts. Whether it's because of the availability of those concepts and their use in greater society that we now use those ideas to study memory or vice versa, we know the brain operates with these concepts, we have embodied them and built systems around them because they are natural for us. I don't know which way it works and maybe it works in both directions, but currently, those ideas allow us to make quite a lot of progress in our understanding of the biology of mind and the biology of memory and thought.

At the same time, it should be relatively straightforward to communicate because we have a common language. The way people interact which each other. They say: "what are you doing this Friday evening?" "I am going to a networking event." Thirty years ago, no one I

know would ever say that, no one would understand what you could possibly mean by that. Today everyone understands. You know that you are not necessarily meeting a friend at the event, but you hope to leave with people that you will now engage with for some purpose. Why are you going there, I frankly don't know, the purpose is literally to network.

MVE: Maybe when we are more aware of how it actually works, this additional experience, if it connects to the understanding that its a constantly changing regenerating experience, maybe this idea of metamorphosis is something that becomes part of the curriculum, and that we say in the future we go to a regeneration event because we know our proteins will be changed because of the experience. Or a morphing event. "I am going to morph this weekend and will be a different person on Monday."

AF: That becomes the goal, imagine that! If that was the goal, because currently it's more like "I want to be me and I don't want to change," but the goal is now to go in order to change.

MVE: And live with the constant dynamics.

AF: Yes, yes. And I know how to deal with it, so it's fine.

MVE: That's a good note to end on. Thank you so much for this inspiring neuron exchange. My brain will never be the same again!

André Fenton is Professor of Neural Science and Director of the Center for Neural Science at New York University. He investigates the molecular, neural, behavioral, and computational aspects of memory. He studies how brains store experiences as memories, how they learn to learn, and how knowing activates relevant information without activating what is irrelevant. His investigations integrate across levels of biological organization, his research uses genetic, molecular, electrophysiological, imaging, behavioral, engineering, and theoretical methods. This computational psychiatry research is helping to elucidate and understand mental dysfunction in diverse conditions like schizophrenia, autism, and depression. André founded Bio-Signal Group Corp., which commercialized an FDA-approved portable, wireless, and easy-to-use platform for recording EEGs in novel medical applications. André implemented a CPAP-Oxygen helmet treatment for COVID-19 in Nigeria and other LMICs and develops the use information technology for the patient-centric coordination of behavioral health services that is desperately needed to equitably deliver care for mental health. André hosted PBS' NOVA Wonders, and chairs the NIMH Board of Scientific Counselors.

Maarten Vanden Eynde is a visual artist and co-founder of the artist-run initiative Enough Room for Space. His practice is embedded in long-term research projects that focus on numerous subjects of social and political relevance such as post-industrialism, capitalism and ecology. Since 2020 he is a PhD candidate at the UiB / University of Bergen in Norway studying material traces that could represent human presence on Earth in the far future.

*All photos provided by the author.

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Fictional Frontiers: On the Fallacies and Fantasies Surrounding Renewable Energy. A conversation with Pamela Tulizo

Maarten Vanden Eynde

Keywords: renewable energy, natural resources, conflict minerals, artistic freedom, contemporary photography, digital manipulation, Goma, DR. Congo, future fantasies

Abstract: Renewable energy seems to be both inextricably and indiscriminately linked to the so-called 'green energy transition,' which is put forward as one of the necessary transitions to avoid further climate breakdown. Little attention is given to the extraction processes of the raw materials needed to produce and store renewable energy, or to the social disruption and inequality they bear and engender. Artist, documentary photographer, and journalist Pamela Tulizo is living and working in Goma, in North Kivu, Democratic Republic of the Congo, one of the most mediated conflictual and unresolved energy frontiers. In her work, she incessantly and without limitations renegotiates the iconography of black African woman throughout history, by restaging and (digitally) manipulating their representation in popular culture and media outlets. She includes raw materials and historical objects in the mix of her poignant alterations of the perceived reality of African women. In 2021, she opened Tulizo Elle Space, a cultural center that empowers women through art, while they metamorphose from merely carrying the burdens of the past into invincible Amazons of the future. This article is a conversation between Maarten Vanden Eynde and Pamela Tulizo about the urgency of shifting narratives related to the mysterious concept of renewable energy and the power of art to confront the present and imagine a different future.

Pamela Tulizo, Matrice #3, 2022.

Maarten Vanden Eynde (MVE): I know you're very busy with your new project, 'Regard Croisé', as part of the residency at ICC/Institute of Colonial Culture, so thank you for taking the time for this conversation. In order to put my fingers immediately into the socket: What does renewable energy mean to you?

Pamela Tulizo (PT): I want to answer like a Lambda person (an average person, Ed.), like someone who lives in Goma, who has been in contact with or in the presence of miners forever but knows nothing about renewable energies. Personally, I know maybe some things, but I speak for all the people who live in the North of the country now, and who know that there are mining activities going on. It's not a question that we will ask someone in the street, nor a question that we introduce at school, or that we will introduce in debates. So it's almost like something really taboo and very fragile for us. We can't discuss it. We don't talk about it. At least for ordinary people, we don't talk about it. It's a question that concerns the authorities, that concerns the traditional chief, and that's all. But for a regular person, Lambda, Lambda, it's not a question we are familiar with. So we don't know what it is exactly. What is certain, is that we live with solar panels, we live with them because there is a problem with the electricity in Goma. So we use solar panels, we use phones, we use computers, and indeed, there are cars that have batteries and all that. So yes, we use it, but we don't know where it comes from. Yet, at the same time, it comes from Goma!

MVE: It's the same thing as in Manono, DRC, where people didn't know lithium, and if they did, they didn't know what it was used for. The world's largest reserve of lithium ore was discovered in the old tin mine of Manono, and when I went there in 2019, in the framework of the On-Trade-Off collective research project, it was so shocking to experience and sad at the same time, because most people have a phone with a lithium battery, but they don't know that it's coming from the stones that surround them.

PT: It's also a bit annoying and revolting because we have to pay a lot of money for the end products while the lithium ore is so omnipresent. It's just there!

MVE: That is something I wanted to touch upon with you as well: the simultaneous presence of mobile phones, computers, solar panels, and other electronic devices, and the raw materials that are needed to produce them. Everything is there at the same time, except for the production and transformation process. That is taken out, hidden, or invisibilized. Do you think it is done consciously? Is it done on purpose to be able to remove raw materials without saying what they are used for, in order to sell the finished products without making a link with the raw materials that are used for its production?

PT: It is done on purpose, yes, to avoid any awareness raising within the local population. What is certain is that the majority of the people of Manono, Masisi, Rutshuru, or even the entire North Kivu region, don't know what all these minerals are used for. I think the only things we are aware of, related to their future use, are gold and maybe diamonds, but other raw materials that need further processing or transformation, we don't know about. This is weird because we are not only the supplier but also the end consumer at the same time. And we consume a lot, particularly the most extravagant models, more than in Europe. We are perhaps the number one consumer of the newest iPhones and MacBooks. So I think it is done on purpose to avoid not only the awareness of the local population but also to avoid a form of redemption by industries and companies, for example.

This brings me to the responsibility of the authorities, of the decision-makers, of the leaders, because they, I'm sure, know. The people who sign the contracts, the people who sign the agreements, they know what's going on. They know that a particular company will exploit a particular material to make a particular device. I'm sure that's clear for them. What's sad is that the government and the authorities do not feel responsible for transmitting this kind of information to the local population, who is going underground, going into the mud, every day, to get the minerals out while taking many risks. I think it is also to avoid people raising the prices. If one kilo is 1000 francs (1,5 Euro, Ed.), and if I know that it will make

multiple iPhones of 1200 euros each, I would raise the price. So, there is a whole mechanism to make it so that there is hidden data to avoid awareness. So yes, it is done on purpose.

MVE: To me, you are living dead center on an energy frontier, with constant international pressure to extract sought-after minerals like gold, diamonds, and the 3T's: Tin (cassiterite), tungsten (wolframite), and tantalum (coltan). But also, geologically, there is a lot of activity with the Nyiragongo volcano erupting regularly. Do you experience it as living on an energy frontier, or is that mainly external projection from foreign governments and media outlets?

PT: Not at all. We are aware of why (it is perceived as an energy frontier, Ed.) because, for the past 25 years, we have been in full-scale conflict. We are in a territorial conflict, we are in a civil war, and we are in political instability. If we look at DRC as a whole and see where there is an intense concentration of a wide variety of raw materials, Kivu in the North jumps out, and that is where there is political instability. Everyone knows. If you talk to people in Goma, they will tell you: as long as we have this abundance of raw materials, we will never be at peace. And today people don't find them very interesting, like oh wow, it's a very rich region and all that. There are two major reasons to say that if we could, we would remove them from the map. That is, if we could get rid of all the minerals, we would do it. So, on the one hand, we have this wealth that is there, so we should live well, like a rich region, but that is not the case. Kivu is among the poorest regions, even within DRC. On the other hand, the mining industry is a source of conflict. So, in any case, it is not an advantage for us. If the government made attractive contracts to ensure the population benefits from this wealth, it could be interesting. But we don't take advantage of it, we rather pay with our lives for it. First of all, in the mines themselves, which are very dangerous, and secondly in the military conflicts that are a result of the presence of valuable raw materials. Because how does it work?

For example, here, where we are right now, we know that there is something valuable. People come and do tests, and now we are sure, but there is also the local population living there. How to create and exploit an extraction site? Of course, the population must leave. And how do we get rid of the population? We create instability. This way, people get out, and we are at peace to have what we want. And the population knows that this is why. Because when there is nothing left, the armed groups disappear, and people can return. So, for us, it's a curse. It's not an incredible thing for which I, personally, can be proud and say, we have this in Goma, and we have that. I know that in the rankings, we are first this, first that, or most this and most that, but I have never been first. And for me, it is like an injustice that has always been there. I admit that this is a problem that I cannot solve. But as an artist, and a journalist, I have a part of the responsibility to do something. To answer, to make it short, for us, if we could get rid of it, it would be a very good thing. Because we would be calm. Like in Kisangani, like in Kinshasa. They are calm because they have nothing. We have all of that here, and it makes us never calm. And it also makes that, from the point of view of the exterior, it's all that is here. Because there is so much focus on these minerals, and the related conflicts, but nothing else.

MVE: And you are trying to change this with your own work, which is like a staging or a creation of an alternative reality, where things are made visible that were not visible before. And at the same time, you help other women through your cultural center, to focus on other things than mining or conflict and help them to find a different path in life while focusing on other (cultural) riches that are also present in Goma. And in order to do that you need to break free from this triangular gridlock that always seems to be present when the NGOs, MONUSCO (The United Nations Organization Stabilization Mission in the Democratic Republic of the Congo), and the mining companies arrive. They always appear to work together.

PT: Exactly! It's the three musketeers, as we say in our country. I am looking for an escape. A shift that I am trying to make to allow the outside world to talk about Goma for

Pamela Tulizo, Double identité, 2019.

something else. Because when we talk about Goma, it revolves around minerals and conflict. So we're all about that. And I know it's not much, maybe, what I've done, but at least someone is doing it. It's about being able to raise awareness among people and raise awareness among the government, in relation to this injustice. Hence the initiative I took to start the Festival of Photography, to allow people to see something else in Goma.

Because we, personally, are not interested in what is under the ground. It brings nothing good, so we are not interested. I try to create other things, like the Women's Centre (Tulizo Elle Space, Ed.), to allow people to see beyond what the media shows and what we can read in the newspaper.

MVE: You use art as an alternative force to show a different reality. Do you think we can

say that art is a different kind of renewable energy, something that we can share, that we can show to someone else, that we can use to educate others? It's something that goes beyond generations, which is also an energy, but a different energy, which is perhaps really renewable?

PT: Yes, we can say that. It's exactly that! Especially for us, people from Goma, art is perhaps all that is left. Art is a renewable energy that we can share with everyone, which is ecological at the same time and which allows us to be connected with each other. Through art, we can transmit things from generation to generation, like who is there, who forges us, who educates us, who makes us strong, because that's what we use to denounce things, to express ourselves. I can say that, personally, it's all I have. If I want to express myself, if I want to say something to someone, it's what I use. Because what is essential is that art is a peaceful weapon we use. When I was a journalist, for instance, I couldn't say those things. When I was a journalist, I was limited. I wasn't free.

MVE: You couldn't manipulate the photos either, because you had to show exactly what was there.

PT: I was very limited at first. We talk about the freedom of the press, but it doesn't exist. I can't just wake up and say, okay, there is this injustice with regard to the mining industry. I would be in prison after that. But with art, it's like I can be free. I can exploit this idea that people or authorities have when they say that artists are crazy. "It's just crazy, leave it there, it's ok," they say, "it's not a big deal. He's going to do contemporary things." When we talk about contemporary art, we have the impression that it's nice, it's glamorous, it's okay. So I won't be taken that seriously. But the message has been passed, the message is

Pamela Tulizo, Double identité, 2019.

coming, and the outside world is waiting. The outside world sees, and the local population sees. At one point or another, the goal is to reach people, and I manage to do that. That's what's important. And art is all we have to do that. When we talk about journalism, it's a bit of an investigation, it's a bit of telling the truth. Yes, to hurt, to expose things that shouldn't be invisible.

MVE: When you manipulate the image, it's a bit like lying, but you lie to tell the truth more clearly in the end.

PT: Exactly. And I accepted this because there is this moment of trickery or change, which is accepted, which is seen as art, as creativity. And in the end, the image hits you. It's the truth that is visible in a mirror. That's why I chose art photography because I wanted to be free. To say what I think, in my own way, without feeling in danger. Because it's like that in Goma, everything can happen. There are kidnappings, there are deaths, there are prisons, there are no rights, there is nothing. So, I found a way to protect myself. And photography for me was the ideal way because it's a still image. I wanted to make films at first, but that was still too exposed because it speaks, it says. So I wanted to make films that don't move, that don't speak. And that's why I went into directing and staging, to have as many details you can have as in a film, but condensed in one photo.

MVE: Let's circle back to Manono. It's a very conflicted place as well, related to the minerals that are in the ground. And at the same time, the lithium ore is still not being extracted there. It is more related to speculation and manipulation of the prices in the London Metal Exchange, the world centre for industrial metals pricing. You were there recently, in Manono, as an artist and photographer. Was it similar to other mining sites you visited, or was it very different? And how was it for you, to work there as an artist?

PT: I think it's different on some points, but there are two common denominators. The conditions of work are the same. There is no protection. It's horrible. People are exposed, just like in North Kivu, to all possible dangers, physical, psychological, and biological as well as chemical. But it was a little bit calmer compared to when I went to a site in North Kivu. Why? Because there is no presence of armed groups. I could work quietly. I also had a different experience when I arrived in Manono because I was there with thousands of women. The majority of people working there, especially in artisanal mining sites where they wash the minerals, are women. I was with my husband, but as long as the woman knew it was me asking the questions and making the work, it was okay. They were very open to me because I was a woman as well. For once, being a woman working in my favor! We had so many discussions, and I was even invited to their homes. To have access to all the information they gave me, was incredible for me.

There is one particular woman, Béatrice Mwamba, who became the main model in the series I made about Manono, who is so incredible. Soo strong! When you look in her eyes, she is happy. But when she washes the minerals finds them and sells them, where do they go? What she
has in her hands will be shipped away and eventually come back, and she has to buy it again… It's like a triangular journey. It comes out of the Congo, goes there, and then it goes there, and then it comes back. When I told her about it, she was surprised. All the women said: "We should be rich then, I don't even have a smartphone, I have a small phone." I was sad at the same time and rebelled at the same time. Because for me, it isn't right that these women work in these conditions, that they live in these conditions.

MVE: It made me think of your future project about Congolese Queens, and how, throughout history, they played a crucial role in the resistance movements in colonial times. The women you photographed in Manono are also queens, super strong women in a more contemporary context.

PT: Yes, actually, I've already done that in a series called Heroine dans l'hombre (Heroine in the Shadow, Ed.), where I made portraits of contemporary women in Goma, working as

Pamela Tulizo, Matrice #3, 2022.

salespersons in the streets, carrying around their portable shop on their heads. In Manono, I did the same with women and the tools they use for digging and washing the soil. The main model, Béatrice Mwamba, is so incredibly strong, and she works in such inhumane conditions, immersed in the mud, coming up to here (pointing at her neck, Ed.), from morning to evening, from Monday to Saturday, every day, with all the possible risks. And what is crazy is that she knows what will happen next. She started washing minerals when she was 10 years old. And until today, at age 26 with 4 children, she does this work. She knows that at some point or another, she will fall ill. And then, in the long run, she will lose her uterus as a result of working under such horrible conditions. It will get damaged, and they will remove her uterus. And although she knows what is going to happen, she doesn't give up, it's not that she is not going to work, it's not that she is going to complain. She does what she has to do. I spent the whole day with her, in her workplace, in her environment, and another day at home. When you see, for example, a smart or intelligent house and the house in which she lives, there is no link. It has nothing to do with it, nothing! I think these women deserve better, they deserve more. They deserve to live in an intelligent house as well.

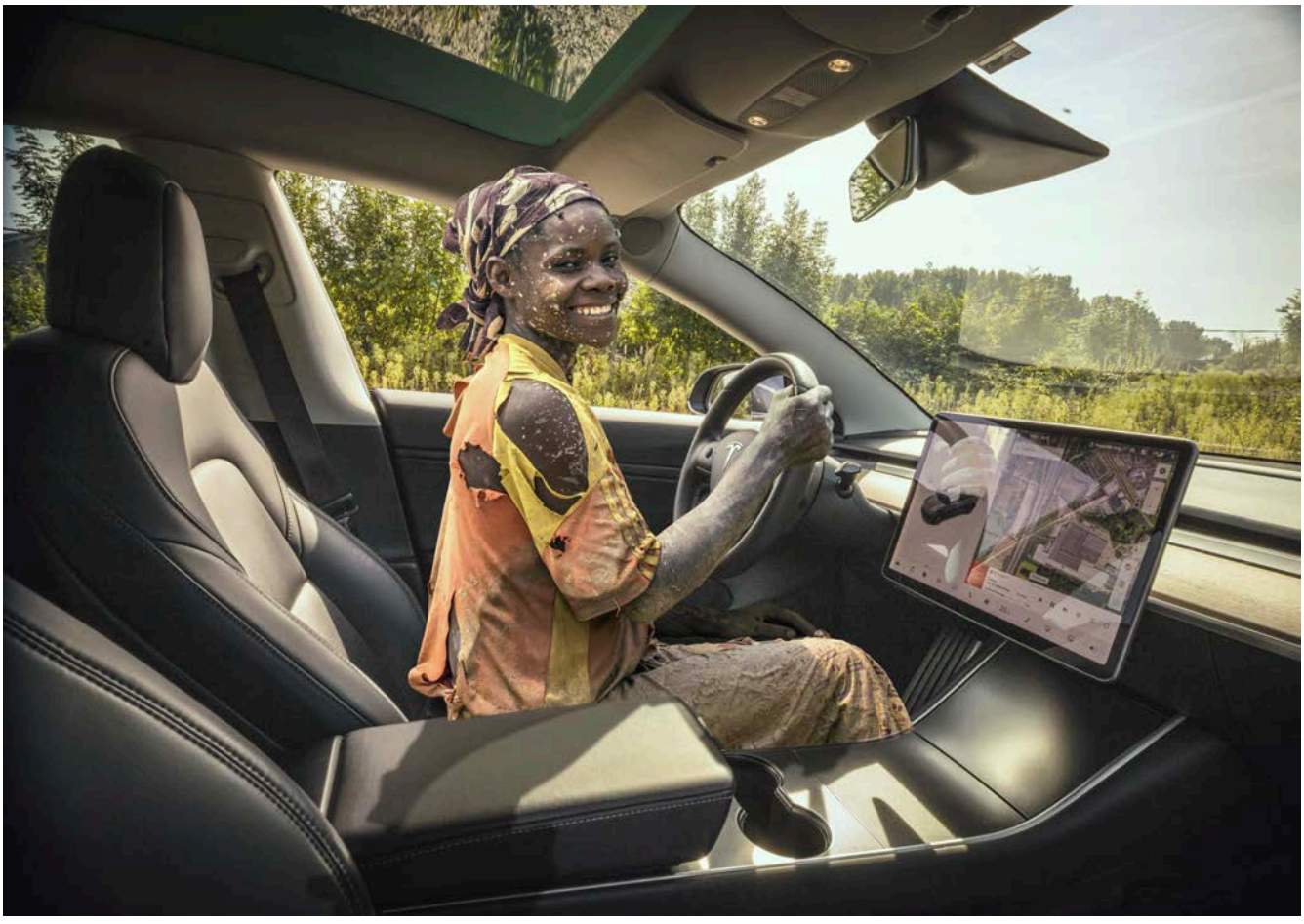
MVE: Exactly, that's why you also put her in a Tesla.

PT: Yes, because she deserves to be in this car. Because if she doesn't exist, this car doesn't exist either. I don't see Elon Musk going to Manono diving in the mud, washing the ore, or going underground to look for the ore. If this person does not exist, all these companies will close down. The phones will cease to exist. So, in a way, they are the rightful owners. But we

have to be pragmatic. I don't control their lives or the situation they're in, which is annoying in the end. There are very few exceptions where the living standard improved for the workers as well. There is a goldmine, for instance, in Durba (in Haut-Uélé, DRC, Ed.) where the gold flows in the streets after it rains. I swear, my husband was there and came back with incredible pictures! When workers revolted, they were given things, but most of the time, it's just promises, like in colonial times. So, at the end of the day, after all that, I tell myself, colonization is never over. Theft still exists, but now in a different form.

There are so many interests related to this, from China to the United States and Europe, that I don't know if it will ever change. Once, when I was on my way somewhere in Central Congo, I heard on the radio, that there was a gentleman who was presenting a plan for the transformation of the economy, which included the introduction of production businesses in Congo. This would allow us to address the problems of unemployment and profitability. The wealth, or at least a renegotiated percentage, would stay in Congo. I don't know…deep inside, I knew it was just a bluff. It's just words like that to soften people, to allow people to move on. There are a lot of people who have made millions in this story, including Congolese people and Congolese authorities, who make a lot of money.

MVE: This fantasy world, this parallel universe, which you are able to create through your art, is that then the only place where all rights are respected? Is it the only place or space where we can imagine a world where there is no social injustice, a world where you are free to say what you think, to show your way of seeing things from your point of view, without prejudice, without discrimination, without fear? Is the only solution then to all become artists?



Pamela Tulizo, Matrice #3, 2022.

PT: Hahaha, It would be so weird if everyone was an artist. Imagine that! It would be a world where everyone is in another world, where everyone doesn't care about propaganda. Everyone lives freely, and it would be nice. It would be a world of peace. But on the other hand, it would be too bizarre. I saw a film once where all people are very gentle. Everything is fine, and everyone is in the process of flying. It would be too weird. No, I prefer this disorder. It's better like that. It would be too... no. It would be too chaotic, that's for sure.

MVE: Thank you, Pamela, for your time and straight-from-the-heart conversation about these complex issues related to renewable energy. It seems to me that if people can't find a way to make energy without human suffering and inbuilt inequality, we should not renew it, regardless of what kind of raw materials are used to produce it in the first place. I wish you all the best with your future projects, and I hope that one day, your imaginary world becomes reality.

Pamela Tulizo is a documentary photographer based in the east of DR Congo in Goma, and founder of TES (Tulizo Elle Space). After initially studying journalism, Pamela graduated from the Market Photo Workshop School of Photography in Johannesburg, South Africa, in 2019. Her work focuses primarily on expressions of female identity. In her series entitled *Double Identity*, which comprises 13 self-portraits, the photographer embodies an African woman torn between her own sense of self and the role attributed to her by a globalized society. She is a contributor to Agence France-Presse and was artist in residence in 2020 in Wiels, Brussels, Belgium. The same year she won the Dior Photography & Visual Arts Award for Young Talents 2020. Recent exhibitions include: *Toxicity*, 7th Lubumbashi Biennale, D.R. Congo (2022) and *Charging Myths*, Framer Framed, Amsterdam, The Netherlands (2022).

Maarten Vanden Eynde is a visual artist and co-founder of the artist-run initiative Enough Room for Space. His practice is embedded in long-term research projects that focus on numerous subjects of social and political relevance such as post-industrialism, capitalism and ecology. Since 2020 he is a PhD candidate at the UiB / University of Bergen in Norway studying material traces that could represent human presence on Earth in the far future.

*All photos provided by the author.

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