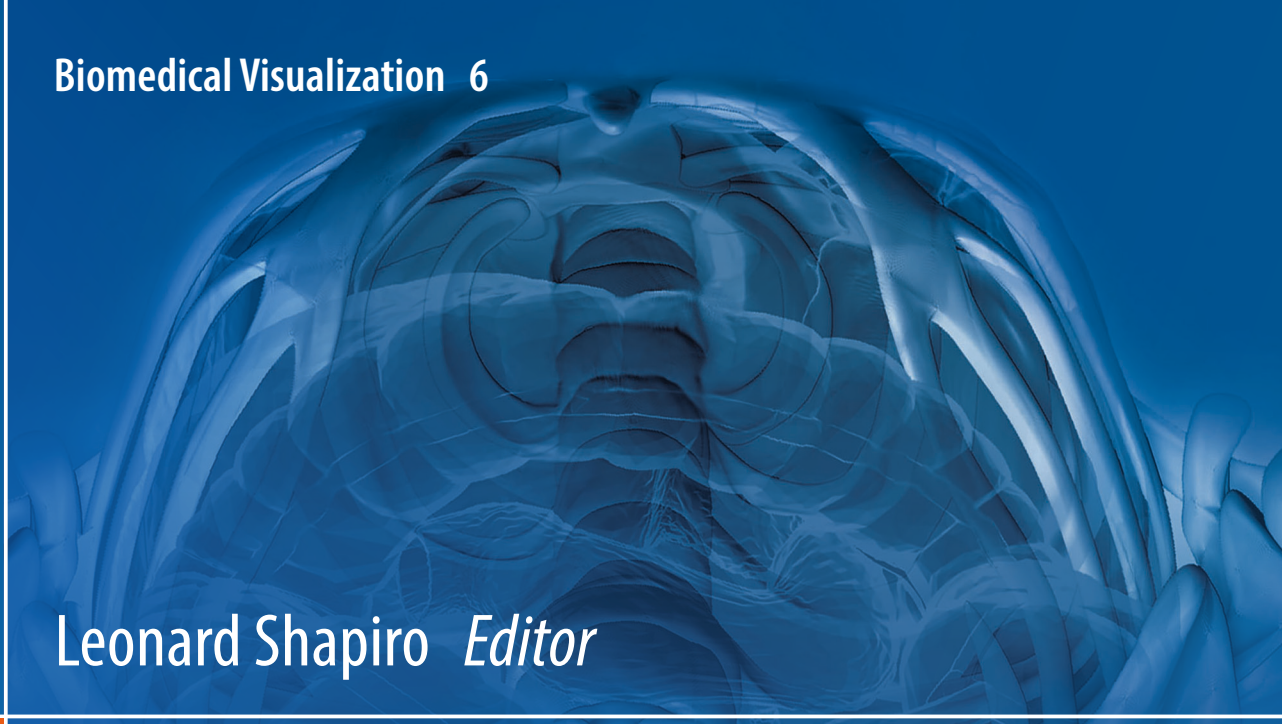
Biomedical Visualization 6



Leonard Shapiro *Editor*

How to use 3D Printing Innovations and Digital Storage to Democratize Anatomy Education

Springer

Biomedical Visualization

Volume 6

Series Editor

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The Biomedical Visualization book series invites contributions related to visualization and imaging in the biomedical sciences and related fields such as medicine, dentistry, veterinary surgery, informatics, and the allied health professions.

This can encompass work in image analysis, workflow methodologies, photogrammetry in science, animations, digital reconstructions and applications, big data and visualizations, educational methodologies, usability and evaluations, augmented and virtual reality, and 3D and 4D technologies, including 3D printing, as well as informatics, e-tutorials, MOOCs, HCI and public engagement. It can be from macroscopic to microscopic but show how we can view data and information related to the biomedical field in a much more accessible, innovative and engaging way using technology.

This series is intended for researchers, clinicians, students, and teaching staff in biomedical and medical schools who use and develop visualization and imaging techniques in medical education, patient care, and biomedical and medical research.

Leonard Shapiro
Editor

How to use 3D Printing Innovations and Digital Storage to Democratize Anatomy Education

Springer

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Preface

This volume in the Springer Biomedical Visualization book series contains chapters that cover bespoke three-dimensional (3D) printing for both human and veterinary anatomical education, a detailed 'how-to' guide with hyperlinks to open-source resources which democratize 3D printing, a digital protocol for the generation of a 3D acellular dermal scaffold for 3D bioprinting, and the 3D printing of a 'femur flute' by an artist-patient working in collaboration with an orthopedic surgeon.

The long history of anatomical models as educational resources is explored in fascinating detail, from historic wax models to the latest, cutting-edge 3D printers. A comprehensive and detailed guide is provided with examples of innovative 3D printing techniques specific to anatomical education, with links to open-source scans for download and 3D printing. A further guide is included to help the reader decide on specific 3D printer models to suit their specific educational needs. A veterinary anatomy educator describes a transformation in teaching and learning methods in veterinary education using augmented reality (AR), virtual reality (VR), and 3D visualization methods like CT or MRI images which can be used to reconstruct complete 3D virtual models, as well as 3D prints from these scans. Following on the 3D printing theme, we have a chapter on the digital protocol for the bioprinting of a three-dimensional acellular dermal scaffold (ADS) for use in wound healing, as an alternative to skin grafting for secondary intention wound healing. The development of bio-engineered ADS constructs is integral to the advancement of wound healing technology. We then follow the personal journey of an artist-patient who worked in collaboration with an orthopedic surgeon to 3D print his femur from digital scans of his femur, which they then transformed into a flute (yes, a musical one). The artist writes about his exploration of his 'disembodied' femur and the fashioning of it into a flute: a reference to bone flutes found at ancient Neanderthal sites, the earliest dating back 53,000 years. A chapter offers a complete and extensive guide to applied anatomy for acupuncture. This is a chapter in four parts that covers the upper limb, lower limb, trunk, head and neck. Each part of the chapter is replete with photographic images of meticulously prepared cadaveric prosections that illustrate and complement the text. An extensive 'bone library'—in the form of a digitized and categorized, online, cloud-based bone repository—is the first digital

human skeletal repository in southern Africa. We then look at vertebral artery variations and its role in clinical conditions, current insights into polycystic ovarian syndrome, and visual interpretation using multiplex immunoassay of serum samples.

Cape Town, South Africa Leonard Shapiro

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My gratitude to each and every author for your valuable contributions to this volume. You have shared your expert knowledge as well as your passion for research and writing with us, your readers.

It is a pleasure to work with our team: Series Editor Paul Rea and Ina Stoeck, Editor at Springer Nature. Thank you for your expertise, enthusiasm, and support throughout the months of work that went into preparing the contents of this book for publication. My thanks to the Springer design and production team for their attention to detail and the efficiency with which they produced this book. You all made this journey a pleasure!

Bone Flute: An Art-Science Research Project

4

Ralph Borland

Abstract

This chapter explores an art-research project that uses biomedical imaging to produce an artwork and exhibition while investigating a research topic. The author is the artist-researcher who designed and produced the project in collaboration with an orthopedic surgeon and a musician, while a research fellow investigating the use of emerging technologies in healthcare in Africa at the University of Cape Town. The author became a medical patient due to a diagnosis of illness during the course of the project, and brought this material into their work. The project centers on the production of the artwork *Bone Flute*, a replica of the author's femur made into a flute, that was made in a public hospital using the surgeon's tools and three-dimensional printing (3Dp) processes. This object formed the centerpiece of a public exhibition in conclusion of the research fellowship, in an artist-run gallery space. The chapter takes the form of a personal essay which explores each of the author's roles as researcher, artist, and patient. It focuses on a number of collaborative relationships that enabled the realization of the artwork, and frames the project, and the chapter itself, as a form of storytelling.

Keywords

Art-science · Interdisciplinarity · Music · Sculpture · Collaboration · 3D-printing

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An artwork in tabloid poster style, highlighting the sensational aspect of the artwork *Bone Flute*, on the exhibition *AIAIA—Aesthetic Interventions in Artificial Intelligence in Africa* (2023)

4.1 Introduction

In a laboratory in a public hospital in Cape Town, three experts[1] are handling a replica of a human bone. They measure, cut, and drill. Tools pass from hand to hand. In the background, a 3D printer whirrs, building another replica of a bone, layer by layer in white plastic. The fourth expert in the room, a filmmaker, documents this operation from behind their video camera. Weeks later, the film they make will be on exhibition in an art gallery in the city of Cape Town, South Africa. Here in this room, hours pass. One of the experts, a musician, picks up the object they have worked on—a femur—and holds it to their lips. Blowing across a hole near the ball of the hip, their fingers move over a series of holes spaced along the shaft of the bone. Musical notes fill the room with a breathy, haunting sound. Their work complete for now, all four-the filmmaker, the musician, a surgeon and an artist-pack up their gear, and the room empties. The only sound remaining is the continued whirr of the printer, blindly completing its task (Fig. 4.1).

I'm an artist and researcher, and one of the experts in the scene described above, which took place at Tygerberg Hospital in Cape Town in early 2023, toward the end of a research fellowship taking place over the preceding 2 years. My expertise is in the investigation and communication of concepts to audiences using symbolic language—especially objects as symbols. The replica bone we worked on is 3D printed from an MRI scan of my femur, and this operation was part of the final stages of turning it into a flute. The artwork, *Bone Flute*, is a memento mori: a reminder of death. My collaborators are an orthopedic surgeon, Rudolph Venter, whose laboratory we worked in, and a musician, Alessandro Gigli—a classically trained flutist and instrument maker. The filmmaker behind the camera is my partner, Dara Kell, then 6 months pregnant with our first child, collaborating with me to produce a short film for exhibition. And, at the time of this performance, I was in my first round of chemotherapy, having been recently diagnosed with colon cancer, for which I underwent surgery and would need a few months of treatment with powerful drugs.

This book chapter is a personal essay, in which the emphasis is on my exploration of my own experience, using the knowledge I acquired while on a journey as a researcher, artist, and patient, with the object *Bone Flute*. It's about the uses of biomedical imaging for art and in healthcare, and the relationships that enabled the work; and it is both about storytelling and an act of storytelling itself.[2]

[1] I'm influenced here by the surgeon Roger Kneebone's book *Expert* (2021) which looks at multidisciplinary collaborations between experts. His "Thread Management" workshop, for example, brought together surgeons, embroiderers, puppeteers, fly-fishermen and engineers around the theme of surgical suturing, via the expert handling of thread.

[2] This sentence lists three topics: technology, social relationships, and storytelling. This triumvirate is a touchstone in my work, inspired by an account I read at a museum of humankind near Cape Town, which proposes these three characteristics as the essential attributes of being human: we are social, storytelling creatures that use technology.

Fig. 4.1 Composite image showing stills from a short film by Dara Kell about the making of Bone Flute (2023) showing Rudolph Venter, Alessandro Gigli, and Ralph Borland

4.2 Researcher

I undertook this work as a research fellow in a humanities research institute at the University of Cape Town. HUMA, the Institute for Humanities in Africa, was in 2022 in the process of reinventing itself as a Pan-African research institute under new leadership, after having fallen dormant since its establishment some 10 years previously. I was among the first cohort of new recruits, joining a research project funded by the Carnegie Corporation of New York called "Future Hospitals - 4IR and Ethics of Care," which asks how new technologies (particularly those of the "4th Industrial Revolution") are changing the work of healthcare professionals in Africa. The "fusion between the human body, new technologies and the experience of being human," it proposes, requires critical attention (HUMA 2024).

My proposal to HUMA was to devise creative and collaborative ways of working with hospital healthcare workers to elicit their ideas about the future of healthcare. Soon after I joined the institute, I posted a call on my Instagram account asking for leads to collaborators. An art school colleague introduced me to their friend Rudolph Venter, an orthopedic surgeon and lecturer in the Faculty of Medicine at Stellenbosch University, who was making low-cost 3D-printed replicas of his patient's bones in his laboratory at Tygerberg Hospital in Cape Town, to use in rehearsals of complex surgical operations (Branson et al. 2021). I already worked as an artist with computer-controlled fabrication technologies, including 3D printing, and anticipated the potential for collaboration this introduction might offer.

My first conversations with Rudolph were informed by some of my reading at the start of my fellowship. One of my key texts in learning more about the impact of emerging technologies on work is Nicholas Carr's book *The Glass Cage* (Carr 2015). Carr's concern is not just with the replacement of human workers by machines, but with the impact on our experience of work when even some functions are taken over by machines. In *The Glass Cage* he explores automation, as a particular type of technological process that takes over functions that might previously have been executed by a person, focusing particularly on computer-controlled automation.

Carr's entry point is in the field of aviation—the "glass cage" of the title is a play on the glass box that contains the pilot in an airplane, surrounded by instrumentation and feedback displays. In early airplanes, the pilot had direct control of their flying machine. Through systems of wires and rods, they could receive direct haptic feedback from distant parts of the airplane, and they could control the movement of the plane directly too, using their bodies. When sensor devices and actuators were developed that intervened in this direct feedback and control, pilots lost part of their felt relationship to their machines. The onward trajectory for airplanes was increasing automation, leading to the role of today's airline pilot, who is largely a custodian of a mostly computer-controlled machine (Carr 2015).

One of the results of this process is the deskilling of the human operator of technology, who ends up alienated from their work, and Carr goes through other examples in which people's skills are diminished by having tasks taken over by machines: from architectural software which tends toward uniformity in building design, to the ubiquitous map applications on our mobile devices, which tend to reduce our way-finding abilities with potentially wide-ranging impacts on our cognitive abilities (2015). One of our desired "experiences of being human," to incorporate the Future Hospitals rubric, is to experience satisfaction in work, including enjoying states of "flow" whether in work or in other experiences (such as playing a musical instrument, running, or rock climbing). One of Carr's concerns with computer-controlled technologies is that by automating aspects of our experience, they diminish the potential for achieving flow.[3]

Working with his surgical team, Rudolph would practice surgical operations several times

[3]The principal researcher and writer on flow, who Carr references, is psychology professor Mihaly Csikszentmihalyi, who published *Flow: The Psychology of Optimal Experience* in 1990.

on 3D prints of patients' bones, so that they would have already solved potential problems that might come up in the surgery itself. This assisted surgeons with their work, especially with patients with atypical anatomy or complex cases, by reducing theater time, reducing blood loss, and reducing X-ray usage in theater (Morgan et al. 2020; Venter et al. 2022). Rudolph hadn't invented this technique but was focused on making it more affordable and so accessible to patients in public hospitals in South Africa. In describing his work, Rudolph foregrounded "embodiment" as one of the benefits of this approach. Surgeons develop skills in and with their bodies that do not reside just in the mind: their ability to manipulate tools and assess material, with trained hands, eyes, ears as well as cognition. These skills are built through experiences that utilize the whole multisensory person of the surgeon—and so surgical simulations should aim to reproduce, or stimulate, as many of these sensory cues as possible.

Simulations are useful for allowing the surgeon to work out approaches to the operation without risk to the human patient, but the more "haptic" (felt) cues that a simulation contains, the better for engaging these accumulated, embodied skills. This distinguishes a screen-based reference for pre-operative planning from approaches using physical models, which allow the surgical team to work together using the instruments they are accustomed to, on the physical copy of the patient's anatomical part or feature. Rudolph's description of the surgeon's state of total absorption in their work during operations (R. Venter, personal communication, September 29, 2021) reminded me of Carr's description of flow, and the use of 3D prints as a way of employing computer-aided technology in ways that did not de-skill the user—retaining the hand skills of the surgeon rather than replacing them—served as a counterpoint to the negative impacts of automation identified by Carr. My reflection on this to Rudolph resonated with how he understood his work.

Rudolph had been introduced to me as a doctor interested in the work of artists. In what our mutual friend who introduced us described as "a lovely balance of technology," Rudolph and his students took haptic drawing classes with an artist I know[4] in which they explored the 3D form and textures of bones using their sense of touch and drawing with graphite. Our first conversations were wide ranging, from sharing work experiences, to discussing the social impacts of technology, and talking about art, music, and fiction. An issue I've long been interested in is technology choice: the potential for people to choose which technologies they use based on their own assessment of their social benefit, rather than simply availability or fashion. Rudolph responded by recommending that I reread the science-fiction novel *Dune* (1965) for its theme of technology choice. I did just that, encountering the book's depiction of a multiplanetary society which has a prohibition on "thinking machines," rejecting computers entirely—something I'd missed in my first reading of the book as a teenager.

In our first conversations, I didn't know precisely how I would work with Rudolph on my research project—just that so far he represented an *entre* to the hospital, and a firsthand informant about the use of emerging technologies in healthcare. I hoped that we could work on something creative together, where I could bring my skills as an artist into a relationship with him as a surgeon working with technology. But I knew that there was a special "something" to our relationship: I enjoyed the multiple levels at which we were able to engage, and I appreciated his warmth and openness to discussing ideas. He appeared to me, from my experience of interdisciplinary collaboration, as one of those valuable figures found across disciplines who are interested in reaching out to people from other fields: and he spoke about collaboration across disciplines as one of his practices, saying "chatting opens doors."

I related too to his identification with human-centered applications of emerging technologies, as this resonated with my own background and ongoing practice as an artist critically engaged with the application of new technologies for cre-

[4]Leonard Shapiro, who teaches the Haptico-visual observation and drawing (HVOD) method, is the editor of this volume.

ative purposes; with art as a medium for collaboration and research; and an interest in the body as material for art. Within a few months of meeting Rudolph, I had revived a past idea for an artwork that involved scanning and reproducing my femur, and determined that we could realize it using his processes: I would have my leg scanned in the hospital, and printed under his supervision. This seemed like a useful confluence of objectives, in representing a concrete project we could work on together that would require me to spend time in his workplaces, and find out more about his ways of working, while making an artwork that could direct the attention of wider audiences both to his work and that of my research project.

4.3 Artist

Bone Flute started out as an idea for another artwork, *Club*, some 10 years previously. I had sketched it out and mocked it up back in 2011 as an independent artwork soon after finishing my PhD (a critical design study focused on the South—see Borland 2011). *Club* was intended to present a replica of my femur as the most basic of weapons, the club. I felt that this artwork might perhaps carry implications about our innate potential for violence. When I shared the idea, several people pointed out to me the opening scenes of Stanley Kubrick's iconic science-fiction movie *2001:A Space Odyssey* (1968) in which an early hominid is introduced to the use of violence, represented by their wielding of a femur as a weapon (I'd seen the movie a long time before, so perhaps the image was embedded in my mind already). The hominid tosses the bone up into the air after smashing a pile of bones with it, and as it spins in mid-air, the film cuts to a space station orbiting the earth, suggesting the links between violence, weaponry and advanced technology.

I have a long relationship with technology in my artwork as an artist and researcher, and particularly with the relationship between technology and the body. As an art student, in completion of my undergraduate degree in sculpture, I used salvaged electronics and synthetic material waste to build bone-like sculptural sound installations, through which I deejayed live, on an industrial site in Cape Town (*Transwerk*, 1997). As a Master's student in Interactive Telecommunications (New York University, 2002), I produced a series of projects in which I turned myself into a human turntable stylus, crafting attachments to my arm that enabled me to "read" the color and textures of my environment and turn them into sound, via a microphone, a miniature video camera, electronics, and computer software (*IRSampler*, 1999–2001). My Master's thesis work was a protective suit for protestors, which amplified the wearer's heartbeat via a loudspeaker and made it audible outside their body (*Suited for Subversion*, 2002).

This last project (*Suited for Subversion*, 2002) led me to focus in my PhD work on objects designed to have functions for the user, and also to communicate to audiences: including types of functional and interventionist art, and some forms of design, such as "discursive design," which focus explicitly on communication to audiences, as well as other forms of design that are ostensibly user-centered but rely on their storytelling capabilities to audiences for attracting funding and support. *Suited for Subversion* was particularly successful at communicating with audiences. Selected for the exhibition *Safe* at the New York Museum of Modern Art in 2005 and later bought for their permanent collection, it attracted a great deal of media attention, and was continuously on exhibition for many years afterward. Through being on exhibition, it reached much wider audiences than in its immediate context of use (street protest) and conveyed information about tactics, situations, and subcultures via a designed object that functions in some ways like a text, using form and symbol (and also, accompanied by written text). The object (the protective suit) has a relationship both to its user and to wider audiences.

Suited for Subversion had led directly to my concept for *Club*, and later *Bone Flute*: they were the result of a conscious intention to extend a theme in my art production that it represented: the repurposing of body parts or bodily functions. *Suited for Subversion* captured my heartbeat and

made it audible in real time outside my body; my heartbeat became audible material for the artwork. What other body parts or functions could I use in this way? I thought about bone as material—this hard, persistent material that outlives us, and can be made into functional objects (I was later to learn from my medical collaborators that orthopedic surgeons are sometimes called "the carpenters of the medical world" because of this quality of bone). The femur is the largest bone in our bodies and so seemed to offer the most potential utility.

I revived this artwork and these concepts for my research project for *Future Hospitals*, using it as a vehicle for collaboration with Rudolph. In the intervening years since the idea first came to me, I had refined the concept of *Club* further, telling a different story with it—a more sophisticated use for the bone replica—a project to make it into a flute. I knew that I'd seen the image of a flute made from a human femur somewhere; that it was an object that was out there in the world. The first visual images that formed in my mind's eye were of a skeleton playing a flute made from a human bone, but I couldn't recall where I had seen it.

Through my research, I recognized that I was tapping into a range of influences that I'd been exposed to: such as Hans Holbein's woodcuts, from his sixteenth-century book *Dance of Death*, which includes many music-making skeletons—an example of the medieval *danse macabre.* Holbein's later painting *The Ambassadors* (1523) is an iconic example of the memento mori with its distorted image of a skull intruding into a portrait of wealthy and powerful men, reminding us that they are as mortal as the rest of us. I'd been introduced to this painting at art school. The *danse macabre* appears in more recent popular culture, such as early black and white Disney cartoons in which skeletons in a graveyard dance and play a range of instruments made from human bone (*The Skeleton Dance*, 1929). Fritz Lang's early science-fiction movie *Metropolis* (1927) of which I had seen a screening with live instrumentation, includes an incidental scene in which a human skeleton plays a femur flute. Rudolph later sent me a scan of a page from a Tintin comic (*Prisoners of the Sun*, 1948) that his child was reading, in which an Incan whistle made from a human tibia appears—and I realized that I had read the same comic book when I was a child, and that it was still on my bookshelf.

I came across archaeological and anthropological material documenting flutes made from human bone used in a range of locations and cultures, some still in practice today such as the Tibetan *Kangling*, a ceremonial flute made from a human femur, and I found confirmation of human bone flutes found in many different parts of the world, from North and South America to Europe, Asia, and Oceania. *Kangling* is made from the bones of holy men or of criminals, and this dichotomy is surmised in other examples of the use of human bones too: they might be the bones of loved ones to keep them close, or the bones of enemies to hold power over them after death. And apart from human bones, flutes made from the bones of animals are the earliest examples of musical instruments yet identified by archaeologists.

All of this is to say that I found confirmation that this idea for an artwork was tapping into a rich vein of symbolic material, spanning wide histories and geographies, and across cultures. These are signs to me of good art-making material: resonant images and symbols that will effectively attract the attention of wide audiences, by reminding them of "something," even if they are not consciously aware of what that is (as I wasn't at first) appealing to us on a subconscious level with images that are proven to be persistently memorable, and that can draw audiences into the more specific information I might want to expose them to. These types of symbols are useful for arresting attention, and for evoking emotions, through sets of associations. This is archetypal and provocative material: bones normally become visible only after death, and human bones are objects charged with symbolism and significance—making them into functional objects produces a frisson, a boundary-breaking that evokes both sacrilege and ceremony.

Making my own bone (albeit a 3D-printed replica) into an instrument carries its only particular meanings. Making someone else's bone

into an instrument is fraught terrain: it depends very much on context and relationship to determine the ethics of doing so. I think that making use of one's own body for material is disarming. It's an act of self-possession rather than of exploitation. Such an act can still be provocative, and evoke feelings of shock, horror, or revulsion in audiences, as in body-based works by artists such as Stelarc, who uses technological apparatus to pierce, manipulate, and permanently alter his flesh. However, I intended to use technology to work on my body in a different way: to use digital technology's capacity for reproduction and simulation to painlessly extract and reproduce a hidden part of my anatomy. While a copy of my bone could now be seen and manipulated outside my body, the original would remain in place.

Normally, a person would have to be dead to have a tune played on their bone. I intended to create a situation in which a living person could do so. While Rudolph's use of technology allows a preview into a living body before opening it up through surgery, in order to heal, my use of the technology implies a preview of the body after death, when the flesh has disintegrated from around the bone. A phrase that came into my mind in devising the work is that I would be making myself "the Pied Piper of my own demise," playing on another association that the flute evokes—as an instrument for charming and enticing. The Pied Piper of Hamelin in the European fairy tale I heard as a child (recorded in many sources, e.g., Grimm 1816/1818) stole the villagers' children, vanishing them into the earth. Was I telling a story through my own artwork that I was leading myself toward my own death? I imagined myself naked, performing in a spotlight on a dark stage, playing a haunting tune on a flute made from my own bone. This was certainly an artwork about mortality in general and my own in particular: the bones beneath the skin, and the inevitably of death—a memento mori. But this work would also be about music and emotion, about the poetry that comes from our human awareness of death, and the desire to celebrate life in the face of it—one of the messages contained in the *danse macabre* or the Mexican *Day of The Dead.* The "healing" in my artwork, in comparison to Rudolph's healing of the physical body through surgical intervention, would not be healing for the patient in a hospital, but perhaps a psychic healing for individuals in audiences as a result of the story it tells. It would also, it turned out, become a source of healing for me (Fig. 4.2).

Most of these thoughts, ideas, and interpretations of what this artwork would mean, appeared to me through the process of research and design over many years, before the object viz. the flute, was made. In order to move the making of the flute from proposal to object would require more work, drawing in further material, and producing unforeseen outcomes. This required opportunity, collaboration, relationship building, processes and technologies, objects, and interactions. By the time I was introduced to Rudolph, I was primed for the opportunity to make this artwork. I also needed a musician to work with, and this introduction came via an unexpected route: because the medical scan of my femur needed to be made suitable for 3D printing, Rudolph referred me to the medical technology company CranioTech (https://www.craniotech.com), who had the skills and software needed to perfect the digital model for 3D printing. Their director Bernard Swart was a musician in his spare time, and his main accompanist and friend was a flutist and instrument maker, Alessandro Gigli—which meant that when I acquired the means to print the femur, I was also introduced to a musician who I could collaborate with on turning it into a flute.

One of the elements of the work that I hadn't anticipated until entering into a relationship with Rudolph in order to realize it, was the chance to make a performance of the process of fabricating the flute. My concept for turning the 3D-printed bone into a flute—drilling holes into it in the right places—was to operate on it in Rudolph's laboratory, in the same way as he would operate on his 3D prints in rehearsal of surgical operations. Though in this case, the simulation was not a rehearsal for the real thing, but the thing itself. I wasn't sure what it would yield, but I felt intuitively that echoing Rudolph's processes, on the same site and using some of the same technologies, would open up opportunities for bringing further ideas into the project. One of the outputs

Fig. 4.2 Ralph Borland playing Bone Flute in the exhibition *AIAIA—Aesthetic Interventions in Artificial Intelligence in Africa* (2023)

of this performance, apart from the bone flute itself, would be a film of the operation that could accompany the artwork on exhibition. My partner Dara Kell is a filmmaker, and she agreed to film and edit a video for the project.

Dara and I worked before the operation to plan out aspects of how we would film it. We looked over photographs of the laboratory that I'd taken on my first visit there, reviewing the colors and forms in the space. We asked Rudolph if he'd be wearing his green surgical scrubs, and Alessandro if he'd be wearing a plain white shirt as he had been so far in our meetings to prototype the flute—and I selected a worker's jacket which I wear regularly, as a complementary color. During the operation, part of my role was to keep thinking about how what we were doing would be captured, and checking in with Dara that she was getting what she needed for her part of the project. So it was that the four of us met in the orthopedics 3D-printing laboratory of Tygerberg Hospital, my partner behind the camera, and Rudolph, Alessandro and I at the operating table, to produce both *Bone Flute* and a film about its making.

The three of us worked together harmoniously on the femur; measuring and drilling the holes, determining what needed to be done at what stage during the process, consulting with one another, picking up on our own self-determined actions and assigning tasks to each other. There were some lovely moments. We needed to drill a hole in the "knee-bone end" of the femur that had to be in line with the internal cavity of the bone, for the outlet of the flute, and Rudolph showed us how he would locate this on a patient, drawing a line between two anatomical protuberances: a distinct overlap between the concerns of the project both medical and musical. Rudolph told me how impressed he was with Alessandro's ability with the tools to carve into the bone—he'd be an asset in the operating theater, he said.

Rudolph's enthusiasm and excitement at how we were applying some of his materials and processes for an unfamiliar, creative purpose was palpable. I was impressed by how well we all worked together for the first time—in my experience it's not certain that this will happen the first time collaborators work together. Something that occurred to me looking back on the experience

was the generosity displayed by all participants; we were reaching out, each from a different domain—surgery, music, art, and filmmaking—and finding common ground. Medicine, as Roger Kneebone points out in his book *Expert* (2021) "is not a science, a craft or an art, but a practice which combines all three"; and there is a commonality between experts from different fields: "being expert is about how you think and see things… it's not simply defined by what you create" (p7).

4.4 Patient

On my first visit to Rudolph's laboratory at Tygerberg, I was there as an artist and researcher, to discuss his work and the creative project I wanted to use his processes to make, but I was also there as a patient. A few months previously, I had injured my hip while running. I'd run a difficult course on a mountainside, in the rain, and later that night in bed my right hip and thigh were hot and stiff. I had several sessions with a physiotherapist and was waiting to see if the injury would heal by itself, but it didn't. I suspected it may be a labral injury, but a scan would help to determine this. I asked Rudolph if he could help me book a scan, and so before I saw him, my first stop was at the patient registration counter to get myself registered on Tygerberg Hospital's administrative system. After I'd met with Rudolph at his laboratory, he directed me to where I needed to drop off my forms to book an MRI scan. As a public health patient, it would be a wait of several months to receive it.

I chose MRI over CT scan because of my concerns about exposing myself to radiation—an example of the kind of agency in relation to technology choice that I'm interested in seeing people practicing more widely. The day before my scan, I started to think: I know what I'm aiming to avoid with a CT scan—X-ray radiation—but how does MRI scanning actually work? I set up a call with Rudolph to ask him more about it. "Well," Rudolph explained, "basically it reorganizes all of your atoms. It moves your most basic particles around" (R.Venter, personal communication, December 10, 2021). That wasn't very reassuring—I wondered whether I'd made the right decision after all. I felt an existential fear around what it meant to have all my atoms reorganized—would I still be the same person afterward, and how would I tell?

My other concern was about money; I wasn't sure how much the scan was going to cost. The hospital staff weren't able to tell me before I had it. As a public health patient without medical insurance, it would be based on my declared income (my fellowship salary). Waiting for the scan in a hospital corridor with my partner on a Saturday morning, we were concerned about what bill I might be landed with. I needed the scan both to find out more about my hip injury and in order to progress my art-research project. It had taken three months from booking it to getting the scan, and I couldn't afford to delay it further on either count. I decided to risk it, and to go ahead with the scan without knowing what it would cost. Fortunately, when I received the bill a month or so later, it was affordable: about 10% of my monthly salary.

My partner left, and I waited my turn for the scan, which was likely to be only in a few hours. My turn came, and I was taken into the scanning room. I lay down on the stretcher that is inserted into the scanner, and the attendant asked if I'd like to listen to music through headphones. She placed the headphones on my head, and I heard elevator muzak. I was nervous, and the music didn't help—the contrast between my mood and the saccharine sounds of panpipes, as if I was on call waiting, was dissociating. I needed grounding. I asked if they could turn the music off, but I would keep the headphones on. With the music off, there was still a hum through the headphones which they couldn't do anything about, but that was preferable to the music. They pushed me headfirst into the machine. The metal interior wall of the cylinder I was in was inches from my face, and I had to breathe mindfully to contain the claustrophobic panic I felt rising in me. Then the sounds started.

Rudolph had told me about the noises I was likely to hear inside the machine. "It has a beat" he told me, "it's like being inside this big

drum'n'bass machine that's set on random." Like a Berlin techno club at 4 in the morning, "a big synthesizer that pumps out beats." He told me I might quite enjoy it, knowing that I was into sound art and electronic music, and he was right. The sounds of the machine were quite extraordinary: pings and grunts like machinic whale sounds, juddering beats like a jackhammer, and deep bass rumbles. In the machine, you must keep completely still, so for an hour and 45 minutes I lay still, breathing as I've learnt to in yoga and meditation, and listening to the sounds of the machine. I thought, I would love to sample these noises and produce a soundtrack for patients to listen to on the headphones that is sympathetic to what they hear from the scanner, rather than completely disconnected.

Weeks after my scan, I went back to the hospital to get a copy of the scanned data, to take to a specialist for my hip. I was interested in the process of acquiring my own data as a patient. As a public hospital, the system was quite antiquated. I made a request by email to an official, who let me know when I could come by to pick up a CD of my data. I came to the office in Tygerberg where the CD was ready for me, and they gave me an invoice to go pay a fee in another part of the building. I went to the cashier, paid the fee, and brought a slip back to the office, to receive my CD. This process was in contrast to my later experience of having scans in a private hospital, when I received a login to an online system, where my data was uploaded and I could access and download it from home.

I'd injured my hip within the first few months of starting my fellowship, and had my MRI scan, which fed into my plans for my work, several months after that. A few months before the end of my fellowship, I was brought back into the hospital for further scans as a patient—a different hospital this time, and for a different purpose. This time, it was for CT scans, and I wasn't in any position to choose otherwise.

My GP had booked me for a colonoscopy, based in part on a family history of cancer—my grandfather had died long before I was born, before my own father was an adult, of colon cancer, at 49 years, 1 year older than I was now. My parents had never spoken about us children having an inherited cancer risk, but as I started to reach the same age as my grandfather, and as my partner fell pregnant and I was set to become a father myself for the first time, I started to think about it—and so I came to be sitting with my partner, soon after coming out of sedation following the examination, in front of a surgeon's desk as he explained that they had found a large tumor almost completely blocking my colon. I was sent for a CT scan the next day to see whether the cancer extended beyond the parts the doctor could see.

Fortunately, the CT scan showed the tumor contained to my colon, and it was operable. A week later I was on the surgeon's operating table, where they removed 20 cm of my colon and connected the ends back together again. It was done via laparoscopy, cameras, and instruments inserted through several small incisions in my abdomen, in addition to one larger cut above my pubic bone at the main site of the operation. This larger cut is almost identical to the bikini-line scar left by a Caesarian. Six months later, I found myself in the same operating theater at the same hospital, though this time it was my partner on the table. I was holding her hand, and we were singing together as our son Ira was born through an emergency C-section, lifted out through a matching incision in her abdomen.

My own surgery took place on the same day that the simulated operation on my *Bone Flute* was first due to take place in Rudolph's laboratory. I had to cancel this initial appointment with Rudolph and Alessandro after I received the results of my colonoscopy. It had taken a long time to find a date that worked for all three of us (and my partner as the fourth) and I was loath to cancel it. It would be another two months before we could reconvene, just in time to complete the flute for exhibition. As it was, on the same day I was first due to drill holes into a replica of my own femur, it was instead my body that was pierced by the surgeon's instruments, on an operating table in another hospital in the same city.

By the time of my diagnosis, I had taken up private health insurance for the first time in my life, encouraged by my partner. This meant that

there was a very short time between my diagnosis and my operation. If I had still been in the public healthcare system, it might have been much longer—and if I had wanted it to take place sooner, it would have cost a great deal of money. Instead, I could get top-quality care, in a comfortable hospital with good facilities, almost immediately. And this may have saved my life.

Something else that supported my recovery was the resonance between my art-research project and this sudden internal accident that had brought me as a patient into the same field I was creating and researching in. My diagnosis did not bring me suddenly into the hospital and into contact with medical technologies from a place outside of this realm: I was already immersed in it. It felt meaningful—this was a story, there was something in it that made sense. And that feeling of meaningfulness can, I think, be a powerful support through a difficult time, as the next few months proved to be.

My engagement as a researcher and artist, working from a professional position, in collaborative, equitable relationships with medical workers, and with a public exhibition to come as a platform for sharing my work, I think gave me power as a patient which might otherwise have been harder for me to feel. I had already exercised choice as a patient in selecting the type of scan for my hip. When I first learnt that a tumor had been identified in my bowels, I wanted to hear from the surgeon about his experience, and his approaches to my surgery. He was willing and able to share this with me. In retrospect he was still exercising his legitimate power as a doctor in how he led me, the patient, into unfamiliar terrain. Reading Kneebone on what he learnt as a doctor, he recounts taking a patient gradually into the world they are entering through sudden diagnosis, as my surgeon did: it was one step at a time, first surgery, and chemotherapy may not be needed. After the surgery, the biopsy—and now chemotherapy is advised.

Beyond the basic questions to establish what the surgeon planned to do, I at first consciously ceded power to the doctors. This was serious business. They reassured me of their experience (around 500 abdominal cancer surgeries for my surgeon) and we'd talked about what they intended to do. Chemotherapy—it sounds daunting, and no one ever says it's easy, but I was not going to find out too much about it beforehand—I'm just going to do it. It was only once I'd started and experienced how unpleasant it felt, that I started to find out more. First was talking to other people who had been through it (surprising once you have cancer how many people you know have had it too, and you didn't know about it). They told me about the permanent side-effects chemotherapy had left them with: neuropathy of their hands and feet. I'd been prescribed four months of chemotherapy, which is less than the standard 6 months on my particular treatment, but halfway in I was concerned enough about the risks I was facing of permanent side-effects versus the risk of a recurrence of the cancer, to put some research into it.

The relationship between duration and efficacy of chemotherapy is notably under-researched—I think historically the idea has been to see it as a life or death struggle in which rather do more than less, and damn the side-effects. But gradually there has been push-back against this approach, and one significant study conducted by International Duration Evaluation of Adjuvant Chemotherapy (IDEA) and published in 2018, which investigated multiple sites and over ten thousand patients to look at the difference in outcomes between shorter and longer durations of chemotherapy treatment (Grothey et al. 2018). This study concluded that for particular risk categories of colon cancer, and particularly drug regimes—both of which I fell into—3 months duration of treatment showed no significantly worse outcomes for survival than 6 months of treatment, but significantly decreased risk of neuropathic side-effects. I took this paper to my oncologist and explained what I'd been thinking: that weighing up the risk of a permanent disabling neurological condition vs no discernibly increased chances of survival with longer treatment, I was considering shortening my course. "Ah, I was at the conference where they announced these results" he told me, "and it's a good study." He told me that he supported my line of thinking, and he would not object to me

deciding to stop at 3 months of treatment instead of the four he had prescribed. I completed my course of chemotherapy at the end of March 2023, and a week later my son was born.

4.5 Story

One of the ways in which I see my work as an artist and a researcher, and how I frame it in this paper, is as an act of storytelling. Stories can be told in many ways: through spoken word, in person, through text and image, and—my personal favorite—through objects. As well as making my own objects, and having my art and design work selected for exhibition by others, I've staged my own exhibitions of my work, and I have worked as a curator selecting work by other artists, designers, scientists, technologists, and the public for exhibitions along a theme.

As an artist and curator, I love to tell stories through collections of objects, texts, images, and other media and experiences. We can define "stories" here broadly, to include factual explorations of real-life phenomena. Most of my curatorial work has been for the institution Science Gallery, which was founded at Trinity College in Dublin in 2008, and now has other university-associated galleries all over the world. Their remit is to explore science through a combination of art and design objects, and scientific experiments and demonstrations. At the end of my PhD, I co-curated *Surface Tension: The Future of Water* (2011) drawing on my thesis, which had as a central case study a novel method for pumping water in developing world contexts. Several years later, I co-curated *Design and Violence* (2016) as a co-production between Science Gallery and NY MoMA.

I see exhibitions, whether of my own work or the work of others, as functioning like object-based essays, which use a constellation of exhibits to explore a theme, supported by texts and events. Part of the work of research and art is in making public—of sharing the results of your work (and sometimes the process of it) with audiences. I knew that with this project, my main output would be an exhibition that would allow me to work with a range of media, with *Bone Flute* at the center; and that in this exhibition my experiences as researcher, artist, and patient would combine (Fig. 4.3).

The exhibition, titled *AIAIA—Aesthetic Interventions in Artificial Intelligence in Africa*,[5] was staged on the threshold of my personal and professional life—in a street-level artist-run gallery called *Brutal* in the complex in Cape Town where I've had my studio for the last 10 years or so. I exhibited *Bone Flute* as an object on a pedestal, near a wall-based installation of images showing some of the references for the project (from memento mori to automata), with the short film we'd made of the operation on a large TV screen (Fig. 4.4). Another smaller TV screen in the space showed a loop of images from my MRI and CAT scans, and a large window served as a light box for a several-meter-square collage of my medical scans. In the center of the space was a table and chairs, for meeting people during the exhibition. I intended to use the exhibition space as a live laboratory for the few weeks it was open, working on material to add to the display, conducting interviews, and talking about my work. During the exhibition, I wrote into a large timeline chart covering the 2 years of my research fellowship. It has columns for the 24 months, and two rows: one row for my personal experiences and one for my art-research work, so that connections along the same timeline can be seen between the two. The flute was performed at the opening and closing events.

At the opening of the exhibition, Rudolph gave a short speech about our work together (Fig. 4.5). "The thing that connected us was the way we think about technology" he said—and he credited me for bringing a perspective to his work that he hadn't yet realized: where his focus had been on the benefit to the patients of his work, and his awareness of how his processes enabled the embodied experience of the surgeon within

[5]While Artificial Intelligence (AI) was intended as the main focus of the *Future Hospitals* research project, few in our team, working at a range of sites across the continent, found much direct evidence for the use of AI in healthcare. My exhibition contained some of my creative and theoretical exploration of AI alongside *Bone Flute*.

Fig. 4.3 The flier promoting the exhibition *AIAIA—Aesthetic Interventions in Artificial Intelligence in Africa* (2023)

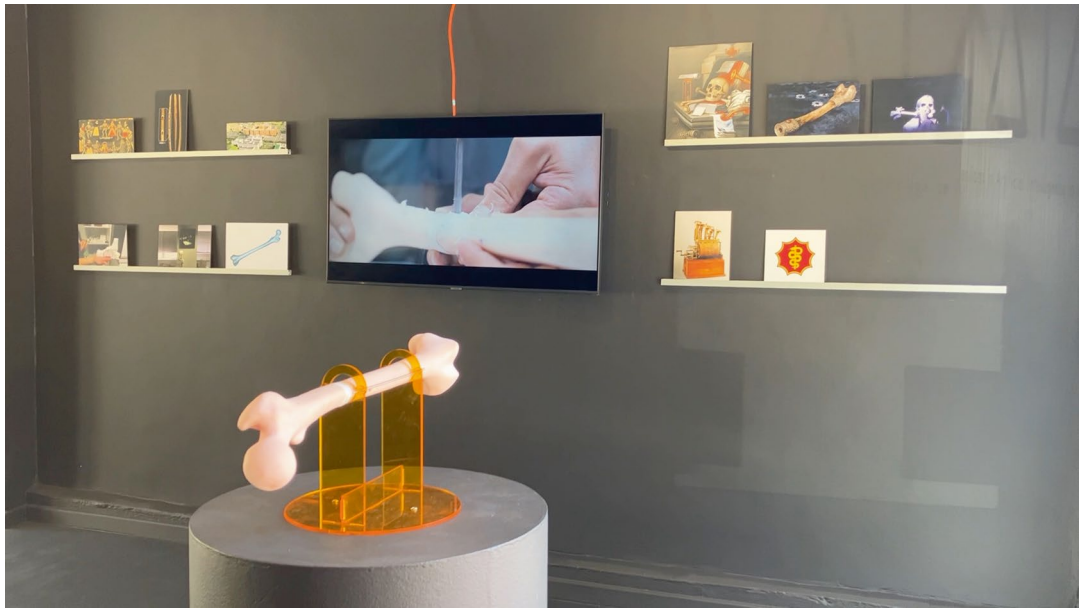

Fig. 4.4 Installation view of *Bone Flute* on the exhibition *AIAIA—Aesthetic Interventions in Artificial Intelligence in Africa* (2023)

Fig. 4.5 Rudolph Venter talking about our collaboration at the opening of the exhibition *AIAIA—Aesthetic Interventions in Artificial Intelligence in Africa* (2023)

pre-operative rehearsal, he hadn't thought about it in terms of the upskilling or de-skilling tendencies of technology in relation to work. That was the frame I had brought to his work, by conveying what I had learnt from reading *The Glass Cage* at the start of my fellowship.

Something interesting for me was that I had not realized before that this was a new perspective for Rudolph; in my memory, I was reflecting back to him something he had already said, perhaps in a different way—yet this had given him something he hadn't seen before. I think there's something here about the significance of framing information in particular ways, and in the nature of equitable collaboration: through conversation and reflecting one another, we both learnt to see the same material differently. I Rudolph found the perspective I had shared with him enriching. I was touched by his credit and noticed that this was the first time he had articulated it to me. As I interpret it, the opportunity for a ceremony and an audience elicited more from him than might have appeared just between us. In telling the story of our collaboration to an audience (which included me) he revealed something new.

I transcribed some of Rudolph's speech at the opening, in which he refers to storytelling:

> The most precious thing that I've got out of this collaboration so far, is learning a lot from you about how to communicate about my work. Because doctors would go: "Wow this is really cool. I segment DICOM images into 3D-printed models to rehearse my procedures" and audiences go "what's he talking about?" Ralph tells a story, and I've literally been taken along for the ride. I've learnt so much from you about how to communicate about my work, how to think about it, how to draw people in. I really appreciate that.

How *to* draw people in, as Rudolph refers to it? How I think about what I'm doing in a project like this is that I'm constructing layers of infor-

mation (such as object, image, and story) that have both surface sensational appeal and that point to wider fields of knowledge. The story closest to Rudolph, and the premise for my research project, is a documentary of his work: the fact that he is developing low-cost methods appropriate to public hospitals in South Africa for scanning and 3D printing patients' bones in order to conduct pre-operative rehearsals. This is a story I recount when talking about *Bone Flute*—it's the starting point for our collaboration.

Then there are the things we both have to say about what his work does: the enhancement of the surgeon's capabilities; the sympathetic relationship of the haptic mode of imaging to surgeon's embodied skills; the counterpoint his example offers to automation's tendency to deskill workers and detract from their embodied engagement with it. This information is mainly conveyed orally (to audiences at the exhibition, and in my other presentations to audiences-conferences, workshops, and so on) and in text (such as on placards in the exhibition, or on my website or other platforms). I designed the exhibition to have rearrangeable elements, which I added to through the course of the 2 weeks it was open, and inhabited the space as much as I could, to be available to give tours of the show. I used the exhibition as a real-life memory palace, with signs to guide my storytelling about the material.

Bone Flute is itself a story, told in object form, supported by image, text, and video. It is a story about the capabilities of technology to perform a kind of magic—to extract hidden parts of ourselves and bring them outside the body; about the goods achievable through collaboration—a surgeon, an artist, and a musician working together on the same project; about art as both a reminder of death, and our celebration of life in the face of it—the memento mori and the *danse macabre*. It also, as a friend pointed out to me at the closing event of the exhibition, points to the potential for objects to be animated, and to speak.[6] What struck them at seeing me play the flute was the significance of the breath, rather than the bone; the breath that animates the bone, and is shaped by it to make sound.

When they told me this, it brought back something I'd read in Meghan O'Gieblyn's excellent book about the mapping of religious feelings onto technology, *God, Animal, Human, Machine* (2021) in which she refers to one of the chapters of Ezekiel in the Bible: the story of the valley of dry bones. It contains the redolent image of bones refleshed and brought to life by divine breath. My friend's observation set me on a path to identify animism using bodily remains in other places: such as the Mongolian practice of turning a favored horse after death into a musical instrument, using their hair, skin, and bone to make a type of lyre, through which horse-like sounds are made. So, the stories told by *Bone Flute* were multiplied by its public exhibition and performance, as audiences reflected back to me their reception of the work.

One of the elements of the story told in the exhibition is the coincidence between medical technology as the object of my art and research, and myself as the object of medical technologies once I became a patient in the hospital through illness. Not only that coincidence but the ones that preceded it: at the start of my fellowship my introduction to a surgeon who uses technologies that would help me to realize an idea for an artwork that I'd had some 10 years previously; the injury to my hip soon after meeting him, making a medical scan necessary that would help both to diagnose my condition and obtain the data for the artwork; and finding the other collaborator I needed, an expert musician and flute-maker, thanks to his being friends with the medical technologist printing my femur. And further, perhaps the most resonant overall coincidence: I was working on an artwork about mortality—with my own mortality the immediate subject, given it was my own femur I was reproducing—when I was diagnosed with a life-threatening illness.

One more anecdote: when I was waiting for that first, fateful colonoscopy in the surgeon's hospital rooms, I was reading a book I'd picked up recently on the bargain table outside a bookshop in a shopping mall. Titled *Red Thread: On*

[6]My friend here is the sculptor Gerhard Marx, who I thank for his observation.

Mazes and Labyrinths (Verso Books, Higgins (2021)) it's an account of labyrinths and mazes by Catherine Higgins which becomes increasingly… labyrinthine as it follows a thread from historical and mythical descriptions of labyrinths to the author's own experiences of them. I'm not sure, or I can't remember, exactly what drew my attention to the book. It's a subject that interests me, and I was already intrigued in my research by the figure of the minotaur, who inhabited the labyrinth on Crete, in relation to some of my reading around AI and technology: in James Bridle's book about technology *New Dark Age: Technology and the End of the Future* (2018) he refers to "minotaur chess," in which a computer and a human collaborate to play chess against another human–machine duo (as now practiced by Gary Kasparov, famously the first world chess champion to lose to a computer, IBM's Big Blue, in 1997).

On the cover of *Red Thread* is an iconic image of a labyrinth, as on an antique coin, circular in outline, made up of quadrants of coils turning back on themselves. I was looking at it and thinking about the resonance with my present situation, in which the doctor's instruments would soon be exploring my own internal labyrinth, my intestines, when I reopened the book and turned to the next page. This is what I read:

> To feel trapped within the labyrinth's intestinal coils ushers in thoughts of entrails, of the strange unremembered red tunnels out of which we all, once, emerged … The labyrinth is, then, both a symbol of the body and its fragile mysteries, and a gesture of optimism that a corner of the universe can be mastered and given pattern and order by the human mind. (p.23)

A few hours later, sitting in the doctor's surgery and hearing what he had found inside me with his snake-like scope, I entered the labyrinth of surgery, treatment and recovery, and the image of the labyrinth became, like a *mise en abyme*, a thread which guided me through it. A text on the wall of my exhibition describes this motif, along with the snake, a symbol that entered my work through my plans for a snake-like automaton that will play the flute, wound around it like the Rod of Asclepius, and that came to resonate with my experience of medicine as I grappled with the voluntary poisoning of chemotherapy. I wrote:

> Looking back over the last two years, I feel as though I am following threads through the labyrinth, with the strands of my own personal fate woven into my art and research. The labyrinth became one of the motifs to my experience, along with the bone flute, the most ancient musical instrument we've found, and the snake: the next symbol I intend to combine with the flute. The snake is a symbol of medicine, combining toxicity with the potential for renewal, as it sheds its skin and emerges anew.

Coincidences lend themselves to stories. "The reason we respond positively to accounts of coincidence," write the authors Martin Plimmer and Brian King in their book *Beyond Coincidence* (2019) "ever eager to give them the benefit of the doubt, is because they make such good stories. They have the resonance of myth and fairy tale, with their dramatic shifts of fortune, their spectacular life and death events and their many enchanted objects and preoccupations… a good coincidence story has the gravitas of Greek drama, the difference being that it is true" (p.7).

They describe here the pleasure for audiences in factual stories of coincidence. But before the story reaches an audience, it has meaning for the person experiencing the coincidence. In the real-life stories collected by Plimmer and King, "when coincidences resonate personally and intimately it becomes hard to dismiss them as mere chance, events that are slung together by the wind." Whether or not the coincidences they experience "have a deeper meaning in any truly objective sense," they carry meaning for the person perceiving and experiencing them, for whom they may produce "emotional catharses and transformations." So it was for me. It felt meaningful that I should find myself brought deeper as a patient into the world I was researching and making art in, and I felt supported through a destabilizing and frightening experience by the feeling that my experiences were contributing to a story, and to my work.

4.6 Conclusion

This is a personal essay: a story I have told about my experiences and my ways of working. Biomedical imaging is at the core of the enquiry: used as a means for innovative, low-cost methods

for rehearsing complex surgeries in a public healthcare setting, which are sympathetic to the embodied skills of the surgeon—a positive example of human–machine collaboration; as a way of producing a sensational artwork that makes available a hidden part of a living body; as a means of detection and diagnosis of illness; and as a sensory experience for a patient. The work I conducted as a researcher and artist was made possible by collaboration with others from different disciplines: a surgeon, a musician, and a filmmaker. When the work was exhibited, more relationships were formed as audiences engaged with it. As a patient, I worked with others for my treatment and recovery, negotiating the choices available to me.

Storytelling runs through my professional and personal experiences: using my skills to direct attention to the work of another expert, and to create compelling experiences for audiences that have value in their own right. My narrativizing and making sense of my own experience within the context of my research and art, and my acquisition of symbols to support me, helped me on a difficult personal journey—one that I was accompanied on by my partner, and met by my son.

I'm almost a year and a half post diagnosis and surgery, and no cancer has been detected in the regular checks that I've had since—blood tests every three months, a CAT scan every six, and colonoscopy once a year. I'll continue with these tests for the next three to 5 years, after which they consider my risk to have reduced to the level of life-long remission. My son Ira is turning one in a week's time, and my partner Dara and I are getting married a month after that. Who doesn't love a happy ending? My *Bone Flute* is on a shelf at home, and I practice on it whenever I can. In the end, stories and death are intertwined, with one meant to transcend the other. Art is our medicine in the face of mortality.

Animals die,
friends die,
and thyself, too, shall die;
but one thing I know that never dies
the tales of the one who died.

Gestaþáttr number 77, *Hávamál*, in the thirteenth-century Icelandic manuscript *Codex Regius*.

4.7 Credits

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Project website: https://boneflute.org

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