Stretching Senses

Stretching Senses and Sounding Neurons: Virtual Reality as Design. Anthropological Probe

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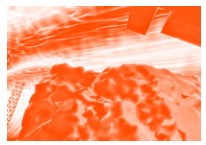
Fig. 1: Inside the last version of the *Virtual Sensing Knife*: interaction of the sensing knife with virtual tissue.

During the COVID-induced break from fieldwork, myself, a graphic anthropologist, and fashion designer and visual anthropologist Yoonha Kim initiated a design anthropology project in collaboration with experimental physicist Fardin Gholami. The *Virtual Sensing Knife* project revolves around an ambitious experiment known as the *Sensing Knife*. The *Sensing Knife* aims at converting the technology of the atomic force microscope (AFM) into a neurosurgical instrument, a machine that could »feel like the hand of a surgeon,« as the project description claims. The hand in this project would be minuscule, however—the machine is set to operate at the scale of the cell. Triggered by the speculative implications of this vision, we imagined an exhibit for the *Stretching Materialities* exhibition (fig. 1). Like other co-curators with their pieces for the show, we displayed the creation process to the public, showcasing several versions over several months. We also published a timeline of the project, which came to include the *stretching senses school*—an attempt at upscaling our experimental collaboration with digital artists. → Intermezzo 5, 343

As anthropologists Paul Basu and Sharon Macdonald (2007) noted, the making of an exhibition brings knowledge processes into a different mode. This is even more so when the format of the anthropological production can take the form of an installation with »new media,« performance, and workshops. The anticipated format between analog and digital brought us to engage with a VR production process. ❑ Exhibition, fig. 6, 126 The installation *Virtual Sensing Knife and Haptic Hanbok*

invited exhibition visitors to an immersive sensorial encounter »down the scale« with free-floating neurons and brain tissues. Inspired by the work of Stefan Helmreich, Karen Barad, and Chris Salter, we invited a sound artist researcher, an interaction designer, and a garment engineer and embarked on an inventive research endeavor. The making process, documented and blogged about in different visual and audiovisual forms, triggered many conversations among us and with the visitors around human-machine perception, soft haptic wearables, force fields, life-energy meridians, and the general process of sounding matter to relate to the more-than-human. This chapter is the first part of the section *Stretching Senses*, which is conceived as a duograph around the *Virtual Sensing Knife* and *Haptic Hanbok*. A duograph presents an elegant solution around the trouble of co-authorship—one field-work, two anthropologists, two texts, and two different takes on a topic from very different backgrounds and perspectives, yet thoroughly influenced by discussion and a shared lived experience of the same situation (Howe 2019; Boyer 2019).

What would be the experience of neurosurgeons if they could sense the body material and cut along the microscopic borders of cells? How would a visitor of the exhibition feel if they were sent to the »bottom of the scale« and vibrated with the blade of the instrument as they sense and cut through organic tissues? In order to flesh out the vision of the physicists, we set out to create a speculative simulation. Imagined and produced by a team composed of medical researchers, physicists, designers, and humanities scholars, the *Virtual Sensing Knife* acted as an elaborate »cultural probe.« ❑ Exhibition, fig. 4, 124 The VR experience was presented in the ground floor rotunda of the exhibition space, below the round lecture hall of TA T, and as one of the levels of the Virtual Elevator.« ❑ Process, fig. 11, 274 → Stretching Virtuality, 90 To introduce the project, one would be tempted to disentangle the many threads that brought it into existence and state a clear research question. However, it is important to inform the reader that this journey isn't moving toward a clear hypothesis to be proven right or wrong. A design-led approach to understanding life worlds of users, »cultural probes« are »collections of evocative tasks meant to elicit inspirational responses from people—not comprehensive information about them, but fragmentary clues about their lives and thoughts« (Gaver et al. 2004, 53). Similarly, we insist that this »cultural probe« is not intended to collect systematized data which could be thoroughly analyzed *ex-post*—on the contrary, we wanted to embrace the fact that the probe and its related experiences were



1 One can quote Hans Ulrich Gumbrecht as a pioneer reflecting on this theme, although by different means and anchored in the tradition of media theories, as he studied the production of »presence« in the humanities (Gumbrecht 2004).

ambiguous and open to manifold layers of interpretations. The ethnographic account of this endeavor may therefore come across as polyharmonic and perhaps slightly dissonant.

Our probe was an attempt at inquiry through »other modes of knowing,« to quote a recent work by the sociologist of science, John Law (2016). He hints at alternative ways of producing knowledge that are indigenous to Western cultures. Reading his arguments in the context of this project, they seem so striking and relevant that I feel compelled to sketch the main line of his argument in this introduction. According to Law, even if Science and Technology Studies have repetitively and patiently explored the limits of academic knowledge, its production remains mostly chained to the scholarly traditions, alienated and captured in text and theory. Law issues a call to explore other modes of knowing, taking the baroque as a Western mode which resisted the dominant academic mode, mingling with and addressing questions of otherness, emotions, and embodiment.[1] In his short history of Western scholarship, Law retraces the »purification« of academic knowledge to the reform of the Church and Protestant ethics, which infused the first scientific academies, and from there spread to universities and all other institutionalized venues for academic knowledge-making practice. As a counter-reform movement, the baroque showed an exalted reaction against this purification process, which he illustrates and analyzes by exploring a work of the sculptor and theater maker Gian Lorenzo Bernini. Law describes this alternative mode of knowing by going through six techniques employed in these artworks that all resonate strongly with our own (modest) endeavor. Theatricality is the most important of them: »Its effects, its dialogues, its scenery, and the multiplication of its artifices are theatrical. Indeed, the artifice is self-conscious, which works to highlight the limits of human modes of representation.« (Law 2016, 29) Second, the boundlessness which characterizes these knowing devices means that it is impossible to clearly establish the division between the inside and outside of these works: »You cannot do what feminist Donna Haraway calls ›the God trick‹ of pretending that you can see it all from nowhere in particular. Instead, you are entangled. You are asked to; you're required to submit and to participate.« (Law 2016, 32) Third, we find the technique of heterogeneity, as these works »multiply their media« (Law 2016, 33). Fourth, there's folding: »The inside becomes the

outside, and the outside becomes the inside.« (Law 2016, 34) Fifth, »distribution, movement, and self-consciousness« is especially relevant to our chosen medium, that of interaction design: »Knowing is a matter of moving. (…) What is happening is a multiplication of viewpoints.« (Law 2016, 36) Finally, sixth, the technique of mediation is crucial: »The baroque knowing becomes sensible to otherness—or the absence of otherness—by working through mediation.« (Law 2016, 39) → Stretching Virtuality, 79 → Stretching Practices, 29 He goes further: »So what if we are interested in ways of knowing excess within the contemporary academy? Of recognizing the whole that is, at the same time, a hole in our artefacts of knowing or experiencing? The implication is that we need to imagine particular machineries of transport and mediation.« (Law 2016, 39).[2]

In this chapter, I will tell the story of the building of such machinery, a machine aimed to transport the otherness faced by the biophysicist and the neurosurgeon, playing with heterogeneous media, folding, and movement to create an artifact of experiencing, which requires the spectators to participate, immerse, and modulate their bodies through wearables, sensors, and 3D modeling. At first, I plunge into the conceptual background that has set the tone for making this machinery. I then outline our fieldwork and relay the experience of biophysicist Fardin Gholami, who plays the role of an accomplice and co-dramaturgist of this work. Further, I describe and reflect on the haptic installation and the careful »sounding« of materials and bodies involved in the research process. ❑ Process, fig. 22, 283 In the guise of a conclusive remark, I dive into the making of toys as probes to get in touch with some of the most dumbfounding aspects of our relation to science and technologies. But first things first, so let's start with situated definitions of some of the terms and analogies that are guiding this project.

Modes of Knowing, Sounding, Probing, and Immersing

The word »sounding« becomes a pun, as anthropologist Stefan Helmreich puts it, when the probe used to »sound« a milieu is actually a vibration, which can be translated or »transduced« to the domain of the humanly audible. With his edited collection of essays, *Sounding the Limit of Life* (2015), Stefan Helmreich renders the sensorial, especially acoustic phenomena, a crucial element in the delicate and complex interplay between water, life, and sound. He already explored this notion in a milestone article, *An Anthropologist Underwater* (2007), in the context of his ethnography of the submarine soundscapes, which he tied in artful ways to other important notions for our project: immersion, cyborg perception, transduction, and the ethnographic as a space to conduct similar operations of immersion.

Before the invention of the sonar, however, »sounding« was a relatively low-tech and effort-heavy sea fare operation. A small object, usually made of lead, was sent to the bottom of the sea to ensure that the boat wouldn't wreck, and lines on a rope, used to pull the »sound« back onboard, would indicate to the »sounder« the water's depth below. Other indications, such as the texture of the bottom were also important, for instance, when an anchor had to be placed and moored onto the ocean's floor. A cavity at the base of the object could be filled up with black soap to make the probe stick, encase, and carry up a sample of the material hit by the sounding probe (ideally, sand) or no sample, if the floor was rocky or barren and hence not hospitable to the iron plough of the anchor. Sounding is a relatively tedious activity, which I remember I have occasionally undertaken as a child and which became more exciting when approaching the landing site due to the imminent danger of shipwreck—and my potential responsibility in this latent event. Continuously communicating by voice with my father in the hull of our little sailboat in Bretagne, plunging the yellow plastic line into dark waters, feeling the probe hit the floor, reading from the pattern of black and red marks on the rope, all these were initial intuitive insights into what Hutchins (1995) defines as a distributed cognitive action (only Hutchins misses on the more sensuous aspects of any encounter with the depths and shallows of the ocean and of matter in general).

One of the key aspects of what Law identifies as the baroque mode of knowing is a multiplicity and heterogeneity of interests and materials, and the composite character of these objects and processes. Similar tendencies can be found in the current turn to multimodal anthropology as a way to engage inventively with the research partners into a »sounding« process, which can be framed as a careful, provocative, and wild, subversive endeavor (Le Calvé, Beck & Stock 2025; Westmoreland 2022). This process can also be found in the attempts to bridge different disciplines together in order to get to new breakthroughs, as in the agenda of *Matters of Activity (MoA)*, which provides the backdrop for this project. → Stretching Practices, 52 Like many

2 In a recent review of the research-creation works in STS, also referring to Law and his previous works, the authors state that »sensual and performative practices and resources may be used as methods in such inquiry and become part of the research process, thus contributing to a broader perspective on and understanding of the research subject« (Salter, Burri & Dumit 2017). The authors also quote Michael Fischer as an important precursor of this mode of thinking STS research, as he proposed as early as 2003 to »bring together science and technology with the social sciences, arts, and humanities, which constitute the analytic understanding and cultural commentaries about the societies of (post)modernity« (Fischer 2003, 139).

others, this well-funded initiative is explicitly modeled after previous exemplary instances of successful interdisciplinary collaborations (Bauhaus, Black Mountain College). With *Virtual Sensing Knife*, we take a speculative and imaginative journey into one of these science projects, aiming, with epic ambition, to reinvent the old technique of the neurosurgical cut. As anthropological staff onboard the exhibition, we initiated a design process as a contribution to the research in order to sound the very different approaches and questions which are intersecting in these projects.

The MoA project *Cutting* brings together three main disciplines in three different experimental settings.[3] *Digital Twin* starts from the possibility of advancing neurosurgery by integrating the latest technologies in computerized imaging with computational neuroscience; *Digital Dissection* aims at developing a haptic VR tool to help virtual paleontologists conducting non-destructive investigations inside delicate samples; *Sensing Knife* intends to insert into the operation room a microscopy technique used by macromolecular physicists to scan matter through contact—or rather through the detection of field force, using a minuscule probe. In a perspective article in the journal *Neurosurgery*, clinical researchers alongside biophysicists, neurolinguists, and computer scientists from *Cutting's* project team claim to set a new agenda for the discipline, a surgical cut that will completely avoid any danger for the patient (and the surgeon) by separating and dichotomizing harmful from beneficial tissue through the power of data—sensing, measuring, modeling, and cutting brains in such a precise (albeit delicate) way that we could shift to the paradigm in which the cut would be considered as a treatment. This article, which I co-authored and co-edited, can be read as the crowning dream of the cybernetic modes of knowing and making in the medical world (Picht et al. 2021). Both an aesthetic and ethical value, this characteristic »beautiful data« framework (Halpern 2014) suggests realizing a neurosurgeon's dream: a procedure that would remove all risk, both during the intervention and afterwards during recovery. For the surgeon, this directly addresses an existential suffering related to this permanent uncertainty while making decisions: the comfort of securing the fact that patients will remain »themselves« when they wake up from the operation: speak, walk, and get back to their lives.[4] This project goes beyond these problems and attempts to accommodate through fieldwork the kind of relation that is envisioned with matter—and host that encounter in a virtual experimental setting.

3 Cutting, Matters of Activity. Accessed June 18, 2021. https://www.matters-of-activity.de/en/research/projects/122/cutting.

4 It is also a dream of precision related to machinery, as the title of the project *Digital Twin* reveals, inspired by mechanical engineering. What has been called »redundant precision« in another domain, as software related to 3D visualization design such as that used by engineers to cut out lenses, enables to think and plan surgical cuts.

What would happen if these machines could sense and care like humans at another scale, »feel like the hand of the surgeon?« This sentence of the project description of the *Sensing Knife* invites us into an immersive and haptic encounter with matter other-than-human. The staging process described in this chapter is a direct response to this thought: a speculative phenomenography, aiming at grasping the kind of interaction with (living and non-living) materials suggested in that sentence. The *Sensing Knife* gathers multiple techno-imaginaries related to the project of the *Cutting* group at MoA: non-harming and molecularly perfect surgical interventions—removing a tumor in a way that not a single cancerous cell remains, in a way that the tissues of cells immediately coalesce, using the »activity of materials« to shape the intervention.

As Tim Ingold (2015) argues in his seminal essay on »a world without objects,« an environment perceived exclusively through its edges and surfaces can only provide us with a shallow understanding of the flow of life permeating the material activity of things. The paradigm of the digital image that flourishes today, with the development of omnipresent mesh-based 3D images and segmentation technologies, is structured around the sense of vision, which is based primarily on the external shape of objects, defined by their surface. Developers and designers are developing new devices that can convey a substance and texture into digital spheres. ❑ Exhibition, fig. 19, 139 What kind of transduction processes can be employed to convey the »sounding« of materials through digital immersive apparatuses? As David Parisi (2018) notes, haptics, once a venerable science, have entered a new »marketing« era since the 1990s. Haptics are supposed to save us from our over-digitalized lifestyles. Critics from the humanities, starting with Richard Sennett's book *The Craftsman* (2009) and ranging to the more recent concept of »sensorimotor debility« (Penny 2020), to the »ecology of attention« by Yves Citton (2017) have played the role of whistleblowers in a more academic register.

Immersive Encounter With Matter
»Down the Scale«

Friday, 28 May 2021. Yoonha and I head to Adlershof, a suburban campus of Humboldt University, home to the Institute of Physics. Fardin Gholami, our MoA colleague, is happy to show us his workplace, Jürgen P. Rabe's lab for macromolecular

Fig. 2: Fieldwork at the lab of Jürgen Rabe with Fardin Gholami, Institute of Physics, Humboldt–Universität zu Berlin. Drawing by Maxime Le Calvé

physics (fig. 2). Together, we are preparing a VR installation for *Stretching Materialities*. The work's project name is *Virtual Sensing Knife*. It is a speculative demonstration of the *Sensing Knife*—which is itself a speculation between physics and neurosurgery. The *Sensing Knife* is a project initiated by Jürgen and later expanded by Fardin: the idea is to turn the sensitive probe of an AFM into a neurosurgical tool which would »sense the brain material as it can also cut through it,« as stated in the initial research proposal. To further explore this idea and the imaginary that it encompasses, together with a small team, we developed a VR installation which allows the visitors to encounter representations of brain tissue at the level of the cell and experience the boundary between zones of different densities (the typical case study in neurosurgery is the ablation of a tumor). The coming together of anthropologists, designers, and scientists has opened up unexpected paths for our project. Today's aim is to »listen to a neuron« with one of the AFM—an idea Fardin came up with when meeting Nico Espinoza, the sound designer we hired for our project.

Fardin has just received a few samples of HT22 cells from Thomas Picht's team at Charité's Department of Neurosurgery (fig. 3). Originally collected from a mouse's hippocampus, they multiply and freely float within a pinkish solution that nurtures them—whereby healthy cells actually interact and adhere to the Petri dish's inner surface. In this experiment, we aim to come

to touch and listen, »as if with a stethoscope,« to an individual living neuron. The cells keep on floating, for now, maybe aware of our plans, perhaps already oblivious of their previous form of life and the act of scientific violence that has set them swimming freely. In a comment on an earlier draft of this text, Fardin wrote: »they are sure alive, their perception of environment might change as we perturb it with an oscillating probe… That's exciting for me to think, I like to think that they are aware of mechanical perturbations surrounding them.«

Fig. 3: Box of culture neurons from a mouse, obtained by Fardin from our colleagues and neurosurgeons at Charité. Drawing by Maxime Le Calvé

Fig. 4: Atomic force microscope in its protective box. Drawing by Maxime Le Calvé

The AFM sits in a box that isolates it acoustically from the outside world. This machine consists of two parts: on top, an inverted optical microscope makes it possible to adjust and control the action of the AFM, and underneath is the actual sensing machine with the micro cantilever (fig. 4). It stands on a tripod above the sample, which is moved underneath. Invented in 1986, its technology has been in constant development ever since (Galison 2006; Dufrêne et al. 2017). The device is built around a swappable microcantilever often made of silicon dioxide, probably one of the thinnest, finest, and most sensitive human-manufactured measuring artifacts. It is used to scan objects whose size is so minuscule that they are impossible to see with visible light—because the wavelengths of visible light are literally too large to interact with such entities. The originality of this technique lies in its bringing a sensing needle into close contact with the material in order to scan it: it is a seeing technology that relies on the sense of touch. In the realm of physics, as Karen Barad (2012, 209) reminds us, there isn't any actual »touch« but only force fields: »The reason the desk feels solid, or the cat's coat feels soft, or we can (even) hold coffee cups and one another's hands, is an effect of electromagnetic repulsion. All we really

ever feel is the electromagnetic force, not the other whose touch we seek. (…) Electromagnetic repulsion: negatively charged particles communicating at a distance push each other away.«

With rotating knobs, Fardin is controlling the position of the cantilever's tip. The first generations of AFM were probing the materials' surface by scanning and touching them. »We were destroying a lot of what we were touching«–Jürgen's voice resonates in my head as I write these lines. He has presented this technology several times to the team and told us a few stories linking him, his lab, corporations, and some lucky students who became millionaires by developing the next generations of these costly machines. After destroying many of their objects of study, the physicists adjusted the mode of operation of the machine: the AFM now conducts its scans by hovering directly above the material, rather than touching it, feeling the repulsion and attraction fields and figuring out the resistance and elasticity. The cantilever oscillates, and the scanning is effectively produced by figuring out the perturbation of this baseline frequency. However, the researchers also used it to manipulate protein single ribbons, »blow« circular protein into perfect loops, or carve their initials on the surface of cells. This is how Jürgen came up with the idea of using it as a blade to perform surgery at the level of the cell–a surgical cut which would not harm the organism as it would elegantly separate matter and enable it to bind and cohere again almost immediately through its inherent activity (regarding the »informed cut,« see Picht et al. 2021). Of course, the professor is perfectly aware that this is an extremely, if not overly, ambitious project, and dares to compare it to a grand historical project: »It took fifteen years for the Americans to land on the moon,« he says with a smile when someone raises the question about the feasibility of this project.

Meanwhile, Fardin is observing the cells floating in a pinkish solution. Fardin points to a grid with a red point on the screen: the red point isn't centered and keeps moving erratically–the vibration frequency of the cantilever is picked up using the reflection of a laser, and the red point indicates the alignment of the laser with the photodiode (a sensor to detect the reflected laser, fig. 5). The restless motion signifies a micro perturbation impacting the reading of the cantilever's movements. He checks out the scene directly using the optical microscope: »That cell is hanging to the cantilever!« he says, showing us the culprit. Enacting his words, he mimics with his whole body the cell clinging to a cliff (fig. 6). His understanding of the situation is embodied, he is starting to correspond with both the AFM and the cell by propelling himself onto the microscopic stage.

Fig. 5: View of the monitor of the optical microscope to position the cantilever on the material. Drawing by Maxime Le Calvé

Fig. 6: Fardin enacting the cell hanging on to the cantilever. Drawing by Maxime Le Calvé

As shown in *Rendering Life Molecular* (2015), »molecular modelers' responsive bodies are attuned to subtle molecular forces and affinities; they hitch rides on the molecular movements they model and allow these intricate forms to inflect their gestures and affects« (Myers & Dumit 2011, 240). A leading AFM brand has chosen to call themselves *Nanosurf*: this name immediately conjures up an image of the macromolecular physicists and AFM operators riding the matter's wave as they scan their reliefs, surfing on magnetic force fields.

Researchers probe into material that lies beyond the scope of their perception, their senses augmented by information inputs that can take multiple shapes–2D or 3D visualizations. Their prosthetic crystalline fingers, sensing matter down the scale, are here portrayed as submarines sounding the ocean's floor. The researchers' perceptive bodies scale down concurrently with their instruments, with their hearts and souls: »Modelers *transduce* these affects through their bodywork and propagate these gestures through performative articulations that excite others into action.« (Myers & Dumit 2011, 241)

The company MicroMotion, one of the manufacturers of the cantilevers, has used the submarine as a key visual for its promotional material, which accompanies the expensive boxes with cantilevers. »The content of this box costs 4.500 Euros,« a label reminds the lab visitors in bold characters on a transparent box the size of an old Nintendo game cartridge. A poster of that company adorned the lab's wall on my previous visit (fig. 7). Imagining the immersion »down the scale,« as the title has it, reminds us of the dreams of the 19th-century explorers and their taxonomic enterprises, the discovery of unknown territories: »You never know what you might catch,« is added below the title as a caption to the image. Once more, scaling

down points towards the experimenter's immersion into a fluid medium, sounding the rock bottom of matter. As mentioned in the introduction, calling it a practical »pun,« Helmreich reflects on the etymology of the verb »to sound« which in the sense of fathoming has etymological moorings in the Old English *sund*, or sea, whereas sound as vibration reaches back to the Old English *swinn*, or melody (Helmreich 2007, 624).

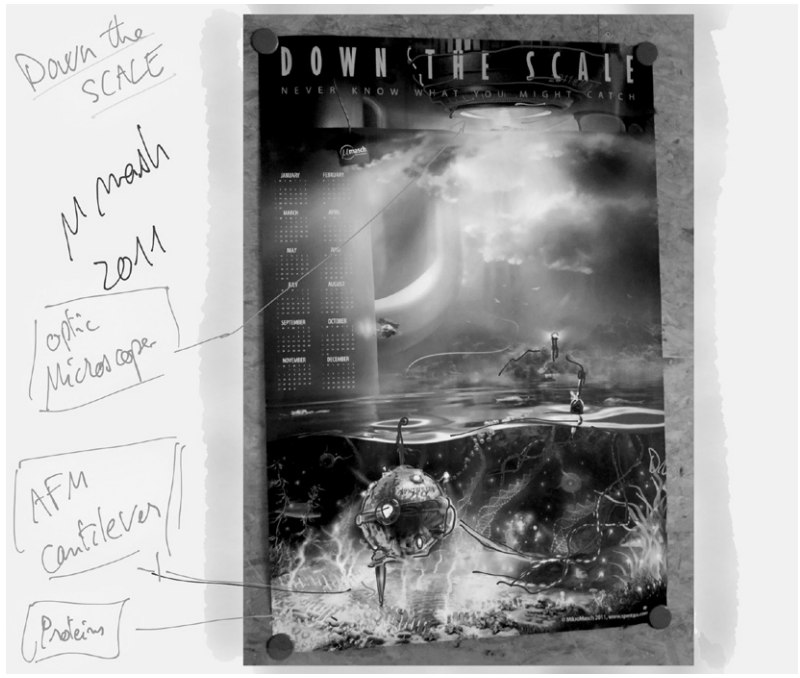


Fig. 7: Annotated photograph from fieldwork: promotional poster calendar from the company MicroMotion (2011) on the wall of the lab

With a small team, Yoonha Kim and I have been toying with and transposing the machinic sensorial immersion of the AFM into a VR installation. Sound soon became an important concern. → Intermezzo 1, 61 »How have underwater soundscapes come into audibility for humans? Devices that permit listening across different media—from water over into air environments (like the inside of the sub)—are key,« writes Helmreich (2007, 624). For *Virtual Sensing Knife*, we are working with sound designer Nico Espinoza and interaction programmer Itaru Yasuda to produce a simulation of Jürgen's vision for a knife that senses and cuts down at the level of the cell. This multimodal anthropological project proceeds as an inventive and iterative »sounding« of the potential intra-actions between physics, design, and neurosurgery. We are exploring techno-poetic paths to relate to the more and less human status of neuronal tissues. We envisioned a virtual reality installation that would invite the visitor of the *Stretching Materialities* exhibition into a tinkered techno-fantasy where the technoscience worlds of biophysics and neurosurgery collide. → Stretching Virtuality, 92 In the last section of this chapter, I will present a portion of this staging process. Here, the probing *is* the making, as the making is driving us to probe and sound in various ways to bring together all these elements into an immersive piece. For half a year, we managed to sustain this nascent stage of the production process (fig. 8). The team experienced it as an extremely productive moment of correspondence between all the disciplines, scales, and bodies involved.

An Immersive Dispositive for an Intra-Active Sounding Process

Designer Itaru Yatsuda developed a first prototype with our team over many meetings and as many formulations of our question: what and how should a simulation of the *Virtual Sensing Knife* be like? We decided to first work on rendering just a kind of blob of the virtual material representing the cell, focusing on the interaction of the knife with the surface of that bubble of 3D mesh. Choosing the platform for prototyping was fairly easy as TouchDesigner is the software with which Itaru is most familiar. Itaru is habitually touring with musicians, producing visual effects for their shows—and this program seemed especially well suited to prototype dazzling visuals meant to be reactive to sound.

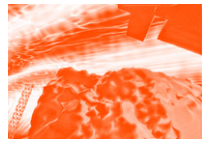
Early in the process, I was asked to write the story of the *Virtual Sensing Knife* to brief the designers—and to convince them to come onboard. The case study, similar to that of the original *Sensing Knife*, is a neurosurgical one: exploring the contour of a tumor inside the brain with a tiny vibrating blade. The dramaturgy that emerged was rather straightforward: Equipped with a VR headset and handheld controllers, the visitor approaches a blob, and touches it with their »hands,« which are equipped with the *Virtual Sensing Knife*. The visitor would then experience »haptically« the surface of the blob and interact with it. In parallel, we started to work on a »haptic vest« for this installation—Yoonha Kim unfolds this aspect of the project in the following chapter. This set-up would make it possible to encounter the digital material and make it resonate with the *Virtual Sensing Knife*, and more importantly, to sense an invisible boundary inside the material, which can be determined only from the difference in feedback it triggers.

Fig. 8: Interaction designer Itaru Yatsuda and Fardin discussing the texture of the virtual material inside the exhibition space. Drawing by Maxime Le Calvé

The idea was to convey the »intra-action« that should be happening as part of the experience: object and subject resonate together in the encounter, as they make each other—»meeting the universe halfway« (Barad 2007). If the conception of the 3D »digital material« and the interaction concept were taking a visual form, it was the sound and haptic feedback that were the most central concern to the project at all times. How can we translate the AFM's vibration to the user? How can they »sense« the material with their whole being? Early in the process, the sound designer Nico Espinoza came up with a reference for the sound experience (Paul Jebanasam 2015). This immersive and digital graphic workplace noise became central to the experience. »The noise becomes the information,« Nico said. This is how we were making sense of the processing of the AFM signal together. With the AFM, the microcantilever almost comes in contact with the material, sounding it and transducing its texture into a waveform—which can then be transformed into sound. The prototype of the handheld *Sensing Knife*, still at the stage of a confidential prototype, is also producing a certain sound due to the vibrations of the blade. The device records the way this vibration is affected by the material, which gives the user a haptic measurement of the physical properties of the materials. In our case study, the user would have to differentiate the healthy tissue from the tumor. The sound is not only heard but also physically transmitted through actuators that are in contact with the user's skin. Their bodies enter the vibration, resonating with the sounding process—which plays together with the interactive visual to drive the immersive experience further.

After months of playing around with Itaru, we had to hire another creative coder for this project, as Itaru reached the limit of his capacities both in terms of time and of his technical expertise. The project had become very intriguing and we were offered the possibility to work with VanTa, one of the most respected members of the creative coder community, at that time based in Berlin. VanTa, who has since then worked with us on many

other fun projects, took over to re-code the entire project over the course of the summer 2021. He elevated our clumsy piece to a level which we would only have dreamt of. We gave him the freedom he needed. We showed him our prototypes and had long conversations with him. He retrieved elements from his own previous works and previous ideas from his digital garage, pointing us to the mathematical equations that he then used to model the interaction of the user's hand with the digital matter. We pondered together about what was and what wasn't possible to do. He understood precisely what we had in mind. He coded a set of shaders in C# from scratch. In the final immersive experience, the sound that the visitor hears, is triggered and modulated by how they interact with the matter, cutting through a wall of reddish cells, softly glowing in the dark. He designed a simple and yet deeply evocative environment: the elevator lands inside of a hollowed human body. The knife appears, small at first, at the dimension of the actual prototype, and it grows—or the user shrinks. The knife follows the hand of the user. ❑ Exhibition, fig. 4, 124



There is always sound in the background, enveloping the user's body, as it is transmitted to their flesh by the haptic wearable. → Stretching Senses, 315 It is the vibration of the oscilloscope of the *Sensing Knife*, ready to feel something at the bottom of the scale. When the tip is brought to touch the material, the tinkling, crisp noise arises, modulated in real time. It reflects, or rather performs, the affect of the material on the vibration of the tip. Through this diffractive perturbation, the user senses the material—maybe they are feeling it, »like the hand of a surgeon,« as they cut through the wall of cells.

The use of VR technology, in particular, strongly shaped our reflection and our practical work. → Stretching Virtuality, 86 In this process, we were joined by many other VR designers grappling with the specific perception conditions and the more general experience that can be created with these devices. On this aspect, a flashback to the early reflections on the technology by philosopher Michael Heim helps to drive the point home:

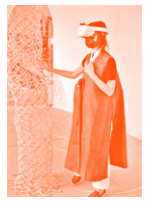
> The VR artist will need strategies for inducing a more receptive atmosphere, so that the user can be open in all directions, receiving signals from and having empathy for other beings. The user must be able to be touched, emotionally moved, by the non-first person [more-than-

> human] entities in the virtual world. The spear of manipulation must join the cup of sensitivity. If simulators serve to train hand-eye and other coordination skills, VR may take a further step and become a training tool to enhance receptivity. (Heim 1994, 127)

Like the VR artists to whom Heim was refering, we were working on a strategy to induce a more receptive atmosphere. Yet the goal of the manipulation was an operation on the sensitivity of the users, not only during but possibly after the experience, as an sensorial imprint on the user—beyond the discourse around the »empathy machine« often associated with VR installations (see Messeri 2022; 2024). We were developing a way to relate to other non-human entities like the cells of a brain, using VR as a method for elevating our understanding of a vision through a speculative act. Yoonha Kim annotated this passage in a previous version of this text: »I would love to bring this back into a group conversation and feel, discuss the ›mode‹ or ›ways‹ we relate to the brain cell. Are there such things as the scale of empathy with a designed object?« The writing of this text was, at the time, not only a reporting process but an active continuation of the sounding, probing, and spanning, more of the heterogeneous and composite material out of which the work and the knowing process are further proceeding.

Conclusive Remarks

The *Virtual Sensing Knife's* immersive dispositive consisted of several dramaturgical layers, arranged around the visitor's body in lenticular and overlapping ways: the exhibition space of the veterinary theater, the VR setting inside of that space, the VR headset and the haptic wearable, the sound design, and the interaction design. ❑ Exhibition, fig. 25, 143 Exhibition-as-research (Basu & Macdonald 2007; Bjerregaard 2019) is one of the defining topics of the exhibition *Stretching Materialities*: during the six months of the duration of this event (29 June 2021 to 31 January 2022) the curating team has shown their working process rather than present to the public a complete and finished product. Ranging from architecture to art history and history of science, the interdisciplinary team explored the exhibition space, its materialities, and the potential it offers to reach out to other scales: ❑ Process, fig. 18, 278–279



> The built environment of the anatomical theater and its relationship to epistemic virtualities steps into the centre of the stage. A set of experimental sensory situations and of spatial constellations are tested in their significance for the exhibition space: ambiguous voids, lush membranes, multi-scalar bridges. Through a Virtual Elevator at the centre of the anatomical theater, the visitors are invited to travel through scales in space and time, encountering hidden ecologies and unfamiliar zones of metabolic interactions. Stretching the boundaries between the digital and the analog, we open up a way to enhance our receptivity to the more-than-human: exploring the remains, the hybrids, and the borders of the physical and the digital. (Excerpt from a draft of the exhibition announcement)

What is this more-than-human (at least in this context)? Here we are suggesting and staging an encounter with neurons, which happens in parallel in the lab, in the VR environment, and in the design process of what we have termed, in the introduction, a »cultural probe.« This immersive field trip may provide a sense, rather than an adequate description, of the neuron's profoundly alien and »more-than-human« agency.[5]

David Abram (1997) coined the term »more than human« in *The Spell of the Sensuous*. His book was also one of the first philosophical works to connect phenomenology, ecology, and the study of aesthetic, spiritual, and sensorial practices. The notion that the planet was undergoing a catastrophic change, which Morton (2013) later termed a »hyperobject,« was explored through the disruption of the modern (western) relation to nature, naming the many entities with which the spiritual practitioners were maintaining relations with the many creatures and things that weave together the »more-than-human« world. → Stretching Spaces, 184 → Stretching Practices, 25 Going back to the ideas of the young Husserl, Abram tells us how subjectivities are informed about the existence of phenomena outside the range of their own perspective by the intuition that other beings have different experiences of their own. The world is then an »inter-subjective« world, it emerges at the encounter of other points of view—in the work of Abram, it goes beyond the visual to embrace the whole range of the sensorium.

Our VR installation is one of the »levels« that visitors could access from the Virtual Elevator in the theater. → Stretching Virtuality, 91 There used to be an actual elevator in the center of

5 »Each group of neurons, any cut or isolated circuit can be thought of as a subject with relation to the rest,« writes Dumit (2006, see also 2014), hinting at the fact that neuroscience hasn't taken the necessary steps to engage in a true »plasticity« of their modes of reasoning, confronted with the multiplication of subjectivities across scales, species, and forms of life.

the exhibition space. It was originally conceived to lift the bodies of animals into the middle of the amphitheater, one floor up, where they were presented and publicly dissected. In a playful dramaturgical move, we transformed this elevator into a vehicle that transports the spectator to other scales to enable encounters with the more-than-human—not in a positivist Comtian kind of way, working out the perfect and logical hierarchy of beings in the world but rather within a fragmentary and contingent science practice framework. While working on this staging, I was often reminded of a similar device that Roald Dahl, in his opus *Charlie and the Great Glass Elevator*, used to transport Willy Wonka, the narrator and their entire family through a set of ambivalent events and experiences (Dahl & Blake 2016). As Boyer and Morton reflect while analyzing another children's book entitled *Tiny Creatures: The Wonderful World of Microbes* (Davies 2016), playful experiences of this type are imbued with a dangerous power, as well as with the possibility to transform the way we relate to the world:

> There is a kind of scientistic »I'm outside the universe, laughing or terrified« quality to it that is politically very disempowering, while at the same time giving one a feeling of total power. (…) Leaving aside for a moment the design of it and the intentionality of this type of a project—how it explores the dizzying, unsettling dimension of scale is really effective and affective. It speaks to a coming-to-terms-with moment. For the designer/producer/artist of the book, for the child reading this and the parent reading it to the child. It's a very gentle way to try to introduce a new set of aesthetic organs into the hyperobjective, hyposubjective world in which we live. (Morton & Boyer 2021, 36)

Throughout this chapter, I reported ethnographically on our amateurish attempts to toy with virtual reality to translate the multisensorial »spell of the sensuous« that physicists experience through their strange devices. As unusual as this fieldwork can come across to more conventionally minded colleagues, I believe that the design anthropologist among them will understand the value of this endeavor as an exhibition experiment: a »probing« and a »sounding« of the techno-imaginaries embedded in the prototype of a neurosurgical tool sensing tissues at the level of the cell—a coming-to-terms-with a vision of the future, which we were given to accompany and to ponder, as anthropologists and as digital makers.

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