Clemens Winkler, Christian Stein, and Object Space Agency (eds.), *Stretching Materialities*.
https://doi.org/10.53198/9783943253955-7

STRETCHING MATERIALS AS A SOUND INSTALLATION

Claudia Blümle in conversation with Anna Kubelík and Peter Fratzl

Intermezzo 1

• Claudia Blümle: Anna, for the *Stretching Materialities* exhibition, the third and latest version of your installation and constructive sculpture, the *Well-Tempered Hygrometer,* was shown in the object laboratory of Tieranatomisches Theater (TA T). ❑ Exhibition, fig. 9, 130 Together with drummer and sound artist Oliver Schmid, you developed a sonic performance in which Oliver brought both the components of the installation and the spaces themselves to sound and resonate through his playing. Dear Peter, as part of our Cluster Day, you were able to listen to and walk through Anna's sound installation. As a material scientist, which aspects do you remember and find surprising or fascinating with regard to your research?

• Peter Fratzl: I was very impressed by the combination of different activities in this work, both acoustically in terms of deformation and movement, as well as experiencing the various media components in one work. Of course, my own research work, which has a lot to do with wood and biomaterials in general—including hair—also appealed to me. In particular, the water-absorbing properties become topical, as is emphasized in the title of the work. While hair is at the center here, I would also name wood—perhaps not quite as directly. Both materials absorb water, which changes their properties, and all of this together naturally results in an image that places this work very much at the center of *Matters of Activity* (MoA).

• CB Anna, you are an artist and architect. What was it like for you to enter into dialogue in this panel discussion between the humanities, design research, and the natural sciences, and what reflections and observations from this conversation about your work during the Cluster Day are enlightening or irritating for you?

• Anna Kubelík: Well, yes, it's interesting for me because this exchange with these different disciplines opens up completely new perspectives that I, as someone who created this, hadn't even considered and I realize that science has a lot to do with knowledge and sometimes not knowing something and doing something on intuition. It's quite liberating, also to reflect on it afterwards with knowledge or to have the exchange. To reveal this to a whole collective of people who have incredible knowledge in different areas can expand my work itself and the reflection on the work greatly. I've realized that I've done things that were simply intuitive, and then I've also done things based on some kind of »pseudo,« shall I say, scientific knowledge because the work originally arose from a childlike fascination. For example, I still find these extreme scientific measuring instruments in museums really fascinating. Whenever I go to an exhibition, I always look for them, these hygrographs, and give them a quick breath touch to see if they really work. (A bit mischievous—I know.) From a design point of view, I have brought various aspects into the work. I have this fascination with the material itself and this movement that takes place in the material, and that goes beyond the horsehair itself and even affects the wood. Initially, this was something I wanted to control, but then I realized that I couldn't, and that's a good thing. I understand it as an artistic process: things are beyond my control. And in that respect, I think I'm more of an artist than an architect, which is my actual background. Architects want to control the material and make it their own so that it fulfills certain functions, while artists free themselves from this »functional« obligation and also allow things to happen that are not foreseen and not planned. In these conversations with various academics, I noticed that the artwork's shape for example apparently made references of which I was not aware from an art historical perspective in relation to this form of movement, the curved movement, which came from a completely different consideration. I actually looked at the sine curve and thought it was the representation of sound in a graphic sense, but in fact this curve was apparently also a reference to an art-historical emergence of form, of design, and I wasn't even aware of that. And I'm also sort of glad that I didn't know that. Even though I'm incredibly inquisitive, it made me happy not to carry this »weight« of knowledge—at least in the process of making it.

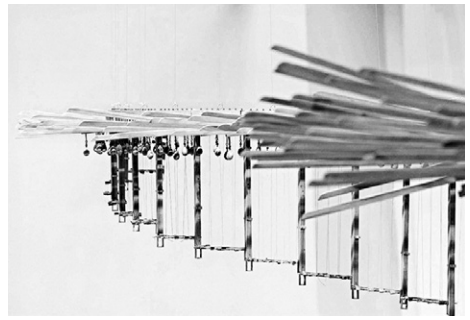

Fig. 1: *Well-Tempered Hygrometer Part III*, detail

I've realized that when I act as an artist and exhibit works—and this work in particular—, the various viewers have different associations. And what I was thinking is not really relevant in this work, but it is interesting for me to realize that everyone draws their own conclusions about the work based on their own wealth of experience, their own background of knowledge. I think that's crucial and wonderful in art, because everyone understands completely different things through their own references, their own cultural contexts, their own perception and yet, if the observer wants to, they can delve deeper into it and see what I was thinking. I gave a little hint with the title of the work, and the conversation with another scientist was also exciting because he gave me ideas on how I could continue working with other materials that also react to temperature and humidity. And that gave rise to completely new mechanisms. New works can emerge from this, which was also a very exciting, very intensive conversation.

• CB And what materials are these?

• AK These were metals, I think, which react to humidity. Fardin Gholami, my cluster colleague, told me about a material that could be used that would have completely different mechanical properties in order to perhaps create a new kinetic work.

• PF You talked about the architect's control and the freedom that you can give this active material as an artist. And that's what I wanted to touch on, what connects the two, which is cooperation. So it's neither control nor complete freedom, yes, but I don't think you gave the materials freedom, you rather cooperated with the material because you had expectations. Yes, the hygrometer is not controlled, but it is predictable; that is, if we know how the hygrometer will react because the horsehair expands with humidity, then that is a kind of cooperation. Nobody forces the hygrometer to do this, but we know that the hygrometer will do it. I find that much more interesting than the two extremes of full freedom and control. I would also say that knowledge has an impact on art. Indeed, the knowledge about the expansion of horse hair is a prerequisite for what you have done. Knowledge about how wood changes with moisture could be another prerequisite. To illustrate this: in the timber industry, logs are cut in a very specific way, because different parts of the wood expand differently with moisture, which could lead to unwanted warping. I think this knowledge can of course be used

in the same way as the knowledge about the expansion of horsehair, and that is effectively done in architecture, for example when Achim Menges uses self-shaping of wood components in the Urbach Tower. I could also quote Horst Bredekamp, who talks about the cooperation between the artist and the object in the making.

• AK Perhaps I can add something to that straight away: the project was preceded by the fact that I didn't know whether horse hair in particular would react to humidity like in hygrographs. I was told that there is human hair in hygrometers, which is degreased and reacts correspondingly strongly, blonde hair in particular. Scale and musical instruments interested me, so it was a combination of things that perhaps didn't seem to belong together. I think that's something that I learnt from my architecture studies, but that I tend to implement in my artistic work: I put things together that don't really have any connection at first. I replaced human hair with horsehair simply because I was interested in scaling it into something bigger. Horse hair is much firmer, much stronger, it can be stretched for bows. First, I did a lot of experiments, to see how it works and how it can be realized mechanically. Is there a mechanism that can set a lever in motion, and can the horsehair do it at all in terms of statics, in terms of its reaction to moisture? So I used a hairdryer and water and sprayed it. That actually worked. So this cooperation had to come first, for me to see if it worked at all with horsehair. I also looked at lever mechanisms first—I had no idea how levers work—and then slowly approached that until it took on a larger form or took on a larger shape and perhaps this process of experimentation was a prerequisite. Then with the wood, I was under the circumstances that I had to take whatever wood was made available to me for these wooden levers, and some of them are quite bent, so I simply took what was offered to me and I couldn't consciously make this selection because I didn't have the means to do so. I was in the USA in upstate New York and they simply made something available to me, I needed wood and I couldn't choose. If I were to do it again now, I would of course be much wiser and know much more specifically what I would take where and which pieces of wood I would take, but perhaps that will come in the next project.

• CB I would like to take up these questions of »what can be controlled?« and »what is left to chance?«, as they relate to the relationship between order and disorder or chaos in the context of entropy and thermodynamics. I first got to know your work as an immediate performance and not as an installation. What I found interesting about it is the level of rhythms as beat on the one hand and noise as noise, which was closely linked to the acoustics of the materialities on the other. At the same time, each musical performance was different from the other. I remember that at one point all the wooden elements collapsed and the entire structure, which also has something geometric about it, was just lying messily on the floor. I would be interested to know how you—Oliver and yourself—proceed with regard to the activity of the materials, the unpredictable changes, how you weave them into your composition and improvisation? When do you integrate chance via the materials, temperatures, humidity? And how did this compare for you, because you've put on an enormous number of performances. In comparison, this probably also took on the character of an experiment for you, from which you were also able to draw your conclusions. Add to that how Oliver struggles with the weight of the material, such as the wooden boxes, or when he drops them. Perhaps you could also tell us a bit about this cooperation between the materialities, their environments, and the two of you in the sense of a multiple cooperation?

• AK The *Well-Tempered Hygrometer* was the third part of a development. The first part was the kinetic work itself with the horse hair and the wood. In a second step I developed the boxes for it and let the whole kinetic work play through the influence of water. That's when the tonal element was added, because that was actually missing before. It is a big and strong reference to a tonal piece by Johann Sebastian Bach and at the same time there was no sound in the first part of this work, so in the second part, the sound was added but played through water.

• CB Could you tell us more about the role of water?

• AK I actually arranged a water hose through the work until drops of water continuously flowed through the sculpture, dripping through and turning the boxes, originally used for transporting the work, into resonating bodies. (Running through the work, the water again caused a deformation that I couldn't control.) There were sound bars in these boxes, which the drops hit, creating an uncontrollable but perhaps a certain structure of sound by simply not using any minor tones. I only used quasi-pure, harmonious tones and the drops fell as they fell. Depending on the water pressure and the place where it was set up, I could make it more or less fast or more or less intense. But in the end, this sound was like a carpet of sound created from sounds that came out of these boxes, through the drops that dripped down from the sculpture: a controlled, uncontrolled carpet of sound.

Fig. 2: *Well-Tempered Hygrometer Part III*, with drummer and sound artist Oliver Schmid

• CB There is also the other variant in which the recording of the performance and a composition by Oliver was pressed onto a red vinyl disc, which in turn was inserted into a box. If you hang this object on the wall as a picture, you can see the floor plan of drj art projects' gallery in Berlin on the cover of the record. This shows the exhibition view of the *Well-Tempered Hygrometer,* its installation of the hanging sculpture, and the boxes from above. However, this is not completely flat but designed three-dimensionally as a model relief. This cover can then be taken down as a picture to remove the vinyl disc in bright red, which was previously the colored background of the model relief of the cover. This is not only about different medial transfers of space, sculpture, and materials as an installation but also about the relationship between architecture, performance, installation, and music, both of which take the activity of the material as a starting point for artistic work in the same way but by different means. Would you like to elaborate a little on this connection?

• AK Yes, it's always exciting for me to work in an interdisciplinary way. And even if they are both within the artistic field, music and visual arts are as far apart from one another as other scientific fields and that's why you can speak of transdisciplinary work in this case. Because we have transcended our disciplines. I was suddenly involved in this musical performance, going beyond my boundaries as a visual artist. When I was invited to exhibit in the gallery, it was clear that I wanted to develop this work further in a form that perhaps removes the water as the main protagonist again and brings a person into it instead. So Oliver replaced the water. It was interesting for me to consider the context. The gallery had a certain context, and it was clear to me that water didn't play a role for me but perhaps people again, people in a narrower space. How do people react with their density? Well, this was before the pandemic, so originally the idea was that many people would then have this influence on the sculpture, but it all turned out differently after COVID-19. Actually, this performance was only supposed to take place at the beginning of the exhibition opening and at the end, but then the performance became a supporting structure for the exhibition and for the work. I think if you had experienced the performance with an audience of twenty-five or thirty people in this small room in the gallery, it would have been something completely different, but this way we actually did it every weekend exclusively for two visitors, there were only four people allowed in one room. We worked with this restriction, not even the gallery owners were present because that number of people wasn't allowed. We did one-to-one performances with masks, and of course it was heavily ventilated and so on. And this created a structure where booked gallery visits were possible, exclusively for people who had booked a time slot, for an hour, where the work was discussed, a performance was shown, and a follow-up discussion took place, and as a result there was an incredible number of performances. Instead of two, there were over seventy performances over this entire corona period and people experienced these performances in a completely different way. First, they had the chance to experience something live and not via a monitor, which was already a strong deficit in the corona period, and that became very, very clear to everyone. And secondly, there was this intensity of experiencing not only the sound but the sound in combination with the material, the material that moves this whole experience of space, sound, and material. That was very tangible for everyone as it turned out in the follow-up discussions. If I can go back to the structure, the structure suddenly became very, very important in the context of first getting an idea of this work but then also getting this experience of the controlled uncontrollable.

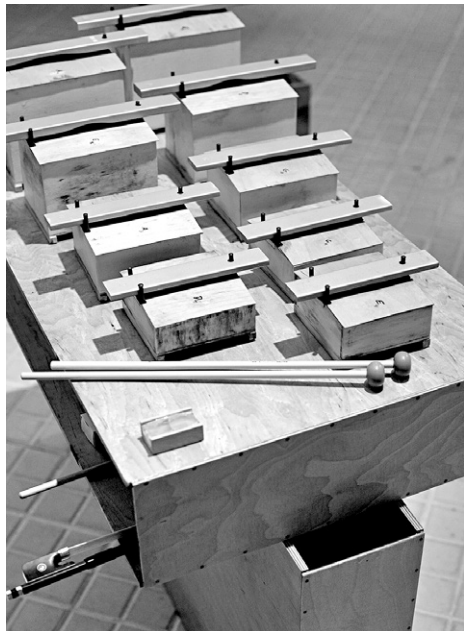

Fig. 3: *Well-Tempered Hygrometer Part III*

• PF What fascinates me now in retrospect, and what I wasn't aware of, is that the work was created independently of the Cluster and our conversations. I initially thought that it was conceived specifically in this context.

• CB I'm happy to pick up on that, as it was actually the point of reference for the invitation to Anna Kubelík. I discovered this sound installation by Matthias Seidel and Christiane Bail at Galerie drj art projects during the pandemic. We could only be a very small group of people in one room to experience the performance by musician Oliver Schmid with the sound installation. It made the experience quite intense, especially hearing and perceiving the materialities, the relationship of water in different states, and the resulting change of form of the whole installation. The title, which recalls the hygrometer, the measuring device that records the humidity in museums to ensure that the artworks do not disintegrate or are destroyed, also evoked materialities. I found it very convincing to use this as a productive starting point for an artistic work. The same holds for the wooden boxes as a means of transport, which at the same time reminded me of the hygrometers as objects in the rooms' corners in museums. After the sound performance, I immediately realized that we should get Anna and Oliver on board for our Cluster and especially for *Stretching Materialities*. The sound installation is also about the question of stretching, and the activity of the material only becomes visible, tangible, and perceptible the moment it changes. This also happens in a very delicate way when the rods in the hanging scaffolding shift or the hair of the violin bow when it tears during Oliver Schmid's performance as he tightens the bow again or relaxes it at the end. All that is part of the performance. For *Stretching Materialities*, we were looking for a position in which the acoustic level of materiality can be experienced.

• PF I see similarities to our scientific work. All life is a reaction to unknown external conditions, all living materials—plants, or even hair—need to react to the environment and adapt to it. This aspect has been partly forgotten in certain areas, where materials are actually enslaved or dominated, which is partially why we now have all these huge problems related to the Anthropocene. That is precisely the failure that arises from the fact that we have tried to control and optimize everything, but since the environment changes, these processes turn out not to work anymore. That means we have to find ways of dealing with conditions of the environment in a reactive, in a more adaptive way.

• AK That's actually extremely important for me as an artist because I have noticed two things: I move in different worlds and time scales, let's say. I work a lot with musicians and improvised music and I find it extremely exciting that they react so immediately, that is, so to speak, in the hundredth of a second. Then in a completely different world, I am a professor in a faculty of architecture and I am constantly confronted with wanting to master material in a way that is functionally oriented so that we think that architecture is something rigid and inflexible. That is actually a big mistake! This is a completely different (time-)scale, because these are scales of hundreds of years and not the »same-moment-reaction.« Perhaps we humans are not even capable of this translation, which is so important today, namely the action and reaction time, that this translation must actually take place immediately, that one must immediately understand what my work is when I do certain actions and this

work is exactly not that! It challenges the patience of the viewer because horsehair moves so imperceptibly slowly and yet one has this expectation that it must react immediately. I've often felt, when I've been in conversation with observers, that they say it doesn't move at all, and yet it does, but you have to be patient, and that's exactly the time span between the solid building that also reacts but very slowly and over many years, perhaps even centuries, and then perhaps not in the way we want it to. I am fascinated by what effect you have as a viewer on the material. The air that we breathe out, the moisture, and everything that we emit through our bodies, which then reacts immediately with the room. Moisture is undesirable for art in museums »because it destroys the art work« and at the same time we want to look at it. We're in this constant conflict with time spans.

• PF I can give you a hint: adaptation must be considered on all these time scales, because if we only look at our living organism, evolution is an adaptation on the scale of many generations. If I train my muscles to a high level, I can change an organ on the time scale of days or weeks. That applies to all our organs. All these time scales are relevant. We also have to bear in mind that time scales are also important for the Anthropocene problems that we have discussed just now. The human-made changes to the environment simply happen too quickly for natural systems to adapt, so the time scale really matters. This is something we also discuss in our research cluster. So things can be too slow, but they can also be too fast.

• CB I would like to pick up directly on the last point, which on the one hand touches on the location of TA T, built under the direction of architect Carl Gotthart Langhans in the period from 1787 to 1790, and on the other hand also touches on the prehistory of materials science. TA T originally was a place where dead horses were dissected. Anna's installation was installed in the original slaughterhouse for horses, today's Gerlach Building, an extension from 1874 and today's laboratory of the Hermann von Helmholtz-Zentrum für Kulturtechnik (HZK). Around 1800, the separation between the organic and the inorganic, between death and the living, became a matter of debate. With dissection and anatomy, one is on the side of death and on the threshold of the physiology of the life sciences. In the *Hygrometer,* one can see a skeleton in the hanging sculpture, while at the same time the question of life and growth is at play with the material of the hair. And it's not just any hair but horse hair. I also found this reference intriguing with regard to the location of the work. It was the place where live animals arrived and were slaughtered to be dissected afterwards. Against this background of the history of science, I am interested in the extent to which anatomy, life sciences, and physiology, including the physiology of plants, are seen as a prehistory of materials science. To what extent is this context used alongside physics, chemistry, and other fields? I would be interested to know to what extent you, Peter, draw a line from the life sciences to today's materials science.

• PF Materials science as a discipline is not that old, probably from the 1950s. Before that, it was either mining and metallurgy or chemistry. The discovery of plastics happened around 1900. The discipline of materials science was actually invented because people realized that there are definitely connections between different types of materials that were previously considered separately: it makes perfect sense for someone who deals with plastics to know how steel or ceramics work and vice versa, and so they need to be studied together. For example, I used to be a professor at a mining university. I taught about steel and iron-carbon diagrams before I got involved with biological systems. Some time ago, I didn't think it would have occurred to anyone in biology to say that materials science is needed there, but today, it's all coming together through an understanding of the significance of structure. Through anatomy, for example, you see how the organs are arranged in relation to each other and from this arrangement you can draw conclusions about their functionalities. That's also something you just mentioned, something you don't actually see, but which is behind what you see. How do the organs communicate with each other, what happens where and why? In a tree, structures may be very different, but they tell us about how the organism functions. The use of materials science concepts in biology is really only twenty to thirty years old. Of course, all our organs or the organs of a tree have biological functions. But these also require specific material properties, which means that materials have a role to play in biology. And I believe that this realization now leads to all these subject areas inevitably growing together.

Because we have talked so much about wood, there is one thing from our research that is just really funny to tell you. When a young tree grows, it starts with a long, thin stem and grows as quickly as possible to get towards the light. You have to remember that plants are in a constant competition with their neighbors, with other plants, for light. And such a thin and long trunk faces the problem that it can be bent incredibly easily, which means that it must be flexible, it should not be like a glass rod. Later on, the problem is different. The stem will have a large load to carry and should not bend under the load and must therefore be stiff. This means that the tree needs to change its material property in the stem as it grows into a trunk. Since the history of growth is stored in the annual rings of the stem, the wood in the stem's center is completely different from the wood material in the outer parts. This reaction to the environment, which means the growth of different wood material at different moments in time, is performative in a certain way, because it incorporates the environment and builds a structure, whereby its history inscribes itself into the stem. A tree invests so much to build incredibly complex structures, from the cellulose molecule to the 12 meter high trunk. Everything is adapted, the structure at multiple scales and the properties, so that burning it in the end simply appears like a crazy waste. This means that we have to learn again how to use every part of the tree in the best possible way, which is mostly to not just burn it. There is a lot of traditional knowledge that has been partially lost, but of course we also have to process this through our type of knowledge, namely through scientific documentation, then this traditional knowledge can also be used with our current methods.

• CB I would then like to ask how you, Peter, work with visualizations and images and also deal with the question of abstraction, which has a graphic dimension. In our *Stretching Materialities* exhibition, it was important to us that visitors could touch and pick up objects. Seeing was therefore not the only possible way to gain knowledge or to perceive. How do you translate and convey the materiality of your object of investigation into images and what role do they play in exploring materiality?

• PF Perhaps the last point is about how to communicate these issues. I'm not talking about outreach, but I'm talking about communication between scientists

from different disciplines and backgrounds. It's not that easy when the background knowledge is very different. Communication needs to be translated into a language, both textual and figurative, that is understood by colleagues so that they can build on it. And the more disciplines there are, the more complex the task becomes. What are we actually communicating? We actually only communicate models, model concepts of something very reduced, descriptions of something incredibly complex that can then be made comprehensible, so to speak. And then you can ask how much truth is in there? Just a certain amount? Which part of the research in one discipline is actually relevant for the other? These are all difficult questions.

• CB Just a quick question about the relationship between images, models, and communication media within science. I was recently in conversation with John Nykatura who told me that when he gets into dialogue with a group of colleagues, from science to science so to speak, paper and pencil immediately come into play and they always draw in the scientific exchange and also communicate through drawing. However, these drawings are all destroyed afterwards and not kept at all. They have no intrinsic value, not even in the sense of outreach, as we know it from the covers of *Nature*. These are also mostly diagrams, abstract drawings that are about describing functions, perhaps cycles or other connections. I would be interested to know whether this is also a practice you employ? Do you also draw in communication or bring illustrations with you in order to be able to enter into scientific dialogue and joint research?

• PF Well, we're not in my office right now, but it looks like this: I have my own desk and then I have a round table for meetings. Behind it is a large screen and a whiteboard. In all discussions about scientific data, the screen is there to call up data and to be able to look at it. The whiteboard is there to make a quick sketch when needed. The really exciting thing is—I'm not very good at erasing the board—that the sketches from the previous conversation may still be around for the next. That's scary but sometimes also stimulating. Such schematics are absolutely essential for the discussion and sometimes people photograph them with their mobile phones, so they don't disappear completely.

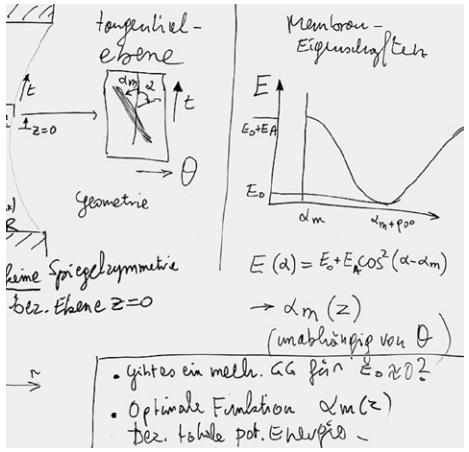

Fig. 4: Scientific visualizations in Peter Fratzl's office

• CB The question of images and visualizations has brought us back to Anna's artistic work. Dear Anna, the exhibition tried to not only show the work but also what actually takes place in secret, during the preparation, in the images and communication beforehand. This is also revealing in terms of the reference to the location. There are still old showcases in the object laboratory and you used these as a display from the laboratory situation to show different stages of your work. Would you like to say something else about the showcases and the reference to the location and perhaps also about these prehistories from anatomy to materials sciences?

• AK Well, I found it incredibly fortunate that you happened to be curating the exhibition and invited me. I didn't know *Matters of Activity* at all, I had no idea of all this research. You just said, this work fits in perfectly. I didn't realize that—it only really revealed itself bit by bit in the course of the exhibition, the conversations, and in the course of my participation in the various activities and exchange opportunities with *MoA*. Each time I was increasingly amazed at how fitting it was to be there with my work: it started with the location of the object laboratory and its connection to horses. The acoustics of the laboratory were also extremely beneficial for our performance. Of course, Oliver took incredible care in setting up these various performance stations in connection with the question of the acoustic effect in the space. It's not a concert hall and yet acoustically, it was able to support us for this performance. Of course, we still had a limited number of people there at the time due to the pandemic, but it was more than just a one-to-one performance. We could accommodate up to fifteen people, or was it twenty?

• CB Twenty, and five were allowed up on the gallery.

• AK Exactly. That was really extremely beneficial for the installation. The way the work was installed was also new, so every time it's reinstalled, it has to adapt and that's perhaps where my architectural heart beats, where I really had to respond to the space, the light, the acoustics, its context, its history, and its current function as a laboratory. It made sense to utilize this space in its entirety. And the display cabinets then allowed me to exhibit the various materials I used, from straps and hair to various different clamps. Suddenly it all became one single object, an art object in itself, which stood in a larger context. And perhaps this question of notation, which I also ask in my degree program in architecture, is also interesting in that I challenge the students in the second semester to write down and draw their everyday life in abstract form, which is extremely challenging. I'm trying to show them how to think about their activities in a new way and to manifest them in a two-dimensional form. But actually there are many more ways of noting things down, there is the incredibly important process of noting things with pencil and paper, notating things in the process of conversation, there is the vinyl you mentioned earlier that records the sound, and not just as a musical score. (By the way: it wasn't pressed like usually in a large quantity of records, but each one was individually inscribed, so actually each of these vinyl discs is unique. This was the result of a limitation of possibilities, but it turned out to be a logical consequence.)

There is the two-dimensional notation, and I also asked a pianist who of course knows the *Well-Tempered Clavier* very well, András Schiff. He has recorded the *Well-Tempered Clavier* several times and worked with an artist who did the cover. Very often the *Well-Tempered Clavier* is recorded in two-dimensional notation by color theory, for example, and I asked him: is there also a three-dimensional notation, a physical manifestation of this score in three dimensions? And he wasn't aware of anything. I said to myself, perhaps I can strive for a three-dimensionality of Bach's *Well-Tempered Clavier* and put it also in relation to the question of the origin of the piano as an instrument. I simply followed the logic of the tonal scales, which came into being at the same time as the *Well-Tempered Clavier* and the piano as an instrument, and I followed this logic in the creation of this object. In other

words, the object did not arise from my intuition to create a spine but from a logic to create a frame with eight horsehairs that have a certain length, which started at a length that is used for hygrometers and the classical measuring instruments and went on to the maximum length, which is a bow (for a string instrument) but can also be the maximum length of a horsehair. And I worked through the scales from C major to A major and so on and translated it into black and white horsehair, so that's the logic I followed, from which the form then emerged. So the form itself emerged by following this logic. That's also why I don't have that many sketches, and that's perhaps also interesting for this discussion: when you have conversations and make notations, you naturally also make a lot of sketches in the artistic or design or architectural process in order to understand how you have to deal with details etc. I wouldn't necessarily publish them, because they are simply scribbles that lead me to this goal, so it's a valuable work process but an active one that remains internal. I have collected them in my sketchbook and also organized them. So I don't throw them away, although I don't actually use them, I would never go back to them. That's perhaps the distinction between all these different forms of notation.

• CB As with the drawings, can you tell us how this work came about and what starting points were decisive for you in terms of the activity of the materials?

• AK Thinking about the origin of the *Well-Tempered Hygrometer,* it has become clear to me that it stems from my family background. I spent a lot of time with my grandparents, who were both musicians and farmers. So for one part I had musical training in my childhood and for the other part I spent a lot of time in the forests and learning how to draw. At the moment the farm with its forest is a big topic in our family. Climate change has hit the forest hard in these last decades. So wood, time scales, »well-tempered« climate are ongoing topics for my practice. For instance on the time scale, there's this saying: you plant the tree under whose shadow you'll probably never lie, the shade of the peaking of time spans and time scales. Currently we are trying to re-forest our woods that have been greatly damaged by climate change. I can't help but wonder to ask myself: is human intervention necessary? And I think these are extremely interesting questions. Is it possible to answer this scientifically? Ethically? Biologically? From a materials science point of view? Is it a question of generations, a socio-cultural question? My great-grandparents planted monocultures and the generations after them were living off them. What we plant now could benefit the generations after us. So the future depends on the decisions we make now. For example: we have a lot of beetle-infested wood that can't be used, can't be sold, can only be used as firewood.

• PF In fact, the question of whether beetle-infested wood can be used in a more sensible, sustainable way will be addressed.

• AK Yes, actually, we have already taken Pelin Asa, a civil engineer in the Cluster, to the farm. We showed her various sawmills.

• CB Thank you both very much for this conversation.

DEVICE BY SABINE HUZIKIEWIZ

Claudia Blümle

Intermezzo 1

Fig. 1: *Device* by Sabine Huzikiewiz

The art piece *Device* by Berlin-based artist Sabine Huzikiewiz operates between design and art, between commodity and object of observation. A double picture frame opens up an intermediate space in which pictures can be hung in a sliding manner on white or black grids. Alongside the wooden frame runs a perforation similar to a 35-mm film strip, created with the help of a 3D printing program and a CNC milling machine. The multiple flexibilities of *Device* allow an open structure for working with images that can become visible and invisible next to each other and one behind the other. As an apparatus for art historical research and as a collection piece, *Device* has now been relocated to Tieranatomisches Theater (TA T). For *Stretching Materialities*, it is the mobile site of exhibition documentation in transition or the starting point for performative situations at TA T. In this sense, *Device* is an object that creates a milieu in which action takes place. The manner of framing or structuring accompanies the practice of inviting other thoughts and involvement—both for purposes of documentation as well as in the sense of an extension of *Stretching Materialities*.

One starting point for this installation was the art-historical work with images, often on a computer, where several open windows and images can overlap. Another starting point was the grid: a group of six grids without purpose, leaning against a wall. A wooden construction, which the artist simply calls »box,« allows them to stand upright. The box consists only of edges, which conversely consist of two types of frames. In this box, the grids are fixed at a set distance from one another, but each grid can slide in its own rail. They are stable yet mobile so that the overlap of the grids is variable and can thus expand and stretch in space. There are two further possibilities for movement. First, the entire frame box can be rolled because it has four wheels. Second, it is possible to remove the grids from their rails or slide them to another location to return them to their slanted position and set them up. These grids can thus remain in the frame, i.e., in the picture frame, or be taken out as an object itself and freely distributed and used in the exhibition space.

Following the idea that these grids contain several frames, they have been given permission to serve a purpose: pictures can be hung within the grid so that images can overlap in the box. The overlap brings together different places and topics, allowing images to be viewed simultaneously. In the context of *Stretching Materialities*, images from various projects are taken and presented in an overlapping way. *Device* is intended to be a movable object that shows its mobility but also an empty space that can be occupied. Accordingly, when the exhibition space of *Stretching Materialities* was almost entirely empty toward the beginning of the project, it took on more of a protagonist role. In the course of the changing situation, the work was more strongly integrated in its use of shifting and rearranging, becoming a commenting and documenting perspective outside of, as well as inside, the exhibition. The constellation of Object Space Agency is thus presented as an installation.

THE ALCHEMY OF ELEMENTS:
Fusing the Organic with the Inorganic

Nina Samuel in conversation
with Lena Dues

Intermezzo 2

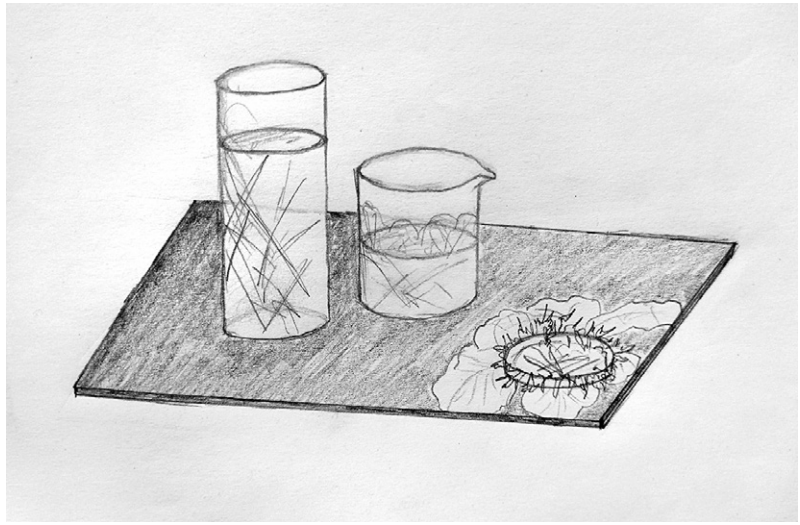

Fig. 1: Lena Dues, sketches in preparation for the installation *Auturgy of Carbamide*, 2021

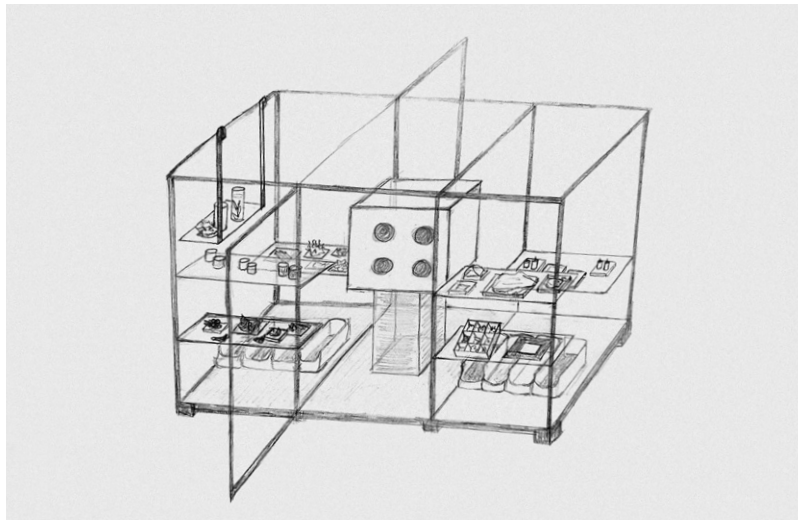

Fig. 2: Lena Dues, first draft for the installation, 2022

• Nina Samuel: The integration of your work was part of our processual development of the exhibition. ❑ Exhibition, fig. 21, 282 What was your first impression of the exhibition? Where did you spontaneously find links to your own work? What did you find particularly exciting?

• Lena Dues: During my first visit, I was incredibly fascinated by the exhibition. The location itself was captivating, and the geological display quickly caught my attention, especially its focus on the activity of rocks and their various forms, which resonated with my artistic interests. I particularly remember clothing items related to the skin's microbiome and bacteria. Also notable was a tiny microscope capable of detecting minuscule things in the body and performing minor invasive procedures. The cloud work and the concept of »scaling« from large to small were other fascinating aspects. They made me think about how we are constantly surrounded by matter, either within us or around us, and how a single movement can set matter into motion or even contain it within us. The combination of these varying perspectives in the exhibition was truly intriguing. And there was also another aspect that appealed to me. I understand the concept of caring for the various forms of life in the exhibition space as an expression of democratization—also in the relationship and interaction between artist and material, and between exhibit and visitor, who act as equals on the experimental platform.

• NiS Let's talk specifically about your work *Auturgy of Carbamide*. It consisted of two glass cylinders and two Petri dishes filled with a urea solution. During the exhibition, crystals formed through evaporation: the urea material formed crystalline sculptures without any further human intervention, thus referring to the self-activity of materials. Can you tell us something about the work and its genesis/creative process from your perspective (fig. 1–2)?

• LD The first thing I did was to find points of reference in the display case with the things that change. The material that changes always plays a role in the creative process for me. I had already worked with various aqueous solutions that form crystalline structures after a while. In particular, the desert rose and the calcite in the display case inspired me because they are also created through a crystallization process.

They illustrate growth as part of material activity. These minerals are formed over thousands of years by the crystallization of lime, gypsum, or barite deep underground. So crystallization as a growth process was already a theme here. I was able to pick up on that perfectly. At the time, I was driven by the question of the sculptural potential of these crystallization processes. I wanted to find out whether I was more interested in the form or the process. And I also wanted to consciously expand the question of the display case in the direction of the crystallization of an organic material.

What also fascinated me was to think about the display case in a different way. It was no longer presented in the exhibition as a closed entity that excluded me as a viewer and that I was not allowed to touch under any circumstances. On the contrary, the display case was opened, I was allowed to come into contact with the objects and to understand them by touching them. There was also something very experimental about the showcase—for example, the experiments with stones and acid, where you could try out processes of dissolution. The processual, the experimental is also very much in line with my own way of working. My work is often processual, and unexpected things happen.

• NiS How did you go about developing an artistic work from these initial approaches?

• LD Out of theoretical interest, I started extensive experiments (fig. 3): on what different materials can the urea solution grow? How does the growth behave? Does it migrate, does it flow in the beginning? What mixing ratios of the solution do I need? What is the effect of temperature? Can I add other substances, such as grains of sand?

Over time, I realized that I wanted to use what was already there: Petri dishes or vessels in which sand or stones were already displayed in the showcase. This was the ideal artistic language for me to pay more attention to the moment of growth or change over time. Hence its presence in the display case as a silent guest—or perhaps better: as a growing guest. And the finished work remains formally at the level of the experiment.

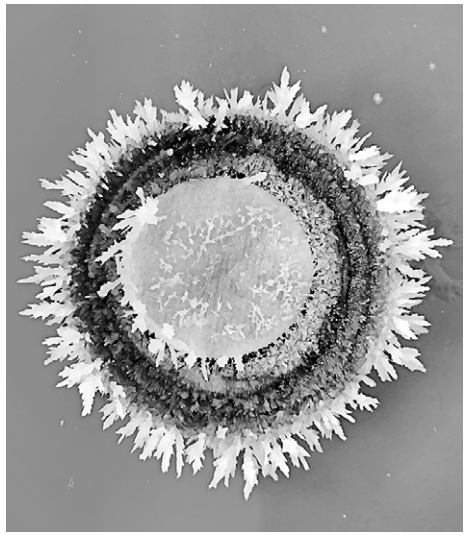

Fig. 3: Lena Dues, experiments on the crystalline growth of urea on various carrier materials, 2021–22

• NiS So could we say that the work is an extension of the idea of the activity and self-activity of material—an experimental extension, or *stretching*?

• LD Following on from the exploration of rock as an active material that is always in motion, the work extends the installation in the showcase to include the moment of the temporally tangible activity of the material as an independent formation of a crystal structure. Depending on the prevailing climatic conditions, this process of transformation should be comprehensible to the visitor within hours or a few days. The change of the exhibition in relation to time is reflected in the change of the urea solution in the glass vessels—the more urea crystal has grown, the more the exhibition has grown as a system: new ramifications have emerged, new connections between contents, people, times have formed…

The idea of the work as an extension is also reflected in the form of the intervention: at first, I thought of attaching the work to the outside of the display case (fig. 2). However, as I experimented and explored the theme, I became increasingly aware that the work needed to be placed in close proximity to the desert rose and calcite because the connection to the stones was so strong. For me, the work is primarily an extension on several levels, rather than a completely new position.

• NiS Why did you choose urea as an artistic material?

• LD Organic urea plays a special role in chemistry because its synthesis in 1828 demonstrated that a metabolic product could be produced in the laboratory without biological starting materials, blurring the boundaries between animate and inanimate nature and ultimately leading to the fall of the doctrine of vitalism. Living organisms produce a large number of inorganic substances, while almost all organic substances can now be produced in the laboratory. The first life forms on Earth were (inorganic) sediment particles metabolizing (organic) microorganisms, which gave rise to the oldest fossils, the stromatolites. The aim of the exhibition was to build a bridge between animate and inanimate nature on a material level and to highlight the inseparability of minerals and life on Earth.

• NiS The connection between organic and inorganic matter has also fascinated you in your earlier work. What is so exciting about it? How have you become interested in exploring the overlap between organic and inorganic matter?

• LD I have a shrimp aquarium at home, and I have always been fascinated by substances or minerals that our bodies or animals have to form, armor-like substances that are a strange in-between thing, on the one hand belonging to the body but also somehow having a different materiality—like fingernails, hair, or even teeth. I explored this for the first time in a work in 2017 and started to recreate natural things—for example, stone druses made of epoxy resin and plaster (fig. 4).

Fig. 4: *Aquarius*, installation, 2017. RADAR, Galerie der Gegenwart, LWL-Museum für Kunst und Kultur, Münster

I am interested in the material or chemical level but also in the question of what is natural and what is artificial. For example, if I use plaster as an »artificial« material to recreate something that nature has made, then I am ultimately using a material from nature. What does that mean for the classification of the object between natural and artificial? During this time, I also bred alum crystals and prehistoric crabs for the first time, which also hatched in an exhibition. I've always been interested in processes that allow you to create your own worlds, which you can then control to a certain extent.

• NiS For many people, stones are initially not something processual and instead represent the eternal, the unchanging, the solid. What are stones to you, and why did you find inspiration in this particular showcase?

• LD At first, I wondered what would fall under the category of stones. I've been working mostly with minerals and it's a little easier to think about their processual aspects. Minerals always have a crystalline structure, as we know from chemistry class. But ultimately, even rocks are not immutable, as the showcase demonstrated very impressively. The desert rose is the best example of this, as well as the weathering processes in which solid material is finely ground. Processes everywhere show us that what seems unchangeable is actually very mobile. These were all aspects that I had not been aware of before.

• NiS How did you hope viewers would respond to your work? Is there a particular feeling or thought you wanted to evoke?

• LD What sometimes takes a back seat in terms of content but is very central to me is the aesthetic aspect of the work. Ideally, the visitor comes to the exhibition on the second day after the installation, when some crystals have already formed, and is initially fascinated on an aesthetic level and wonders what they could be. This is also the reason why one of the solutions was slightly bluish. What could it be? So first of all it's about the fascination of the aesthetics, the look, the form. And then he or she should ask questions about the content,

like, »why is this here in this display case, it's just stones, why is it a liquid?« But for me, too, aesthetic questions were at the very beginning, for example about the sculptural character of the work.

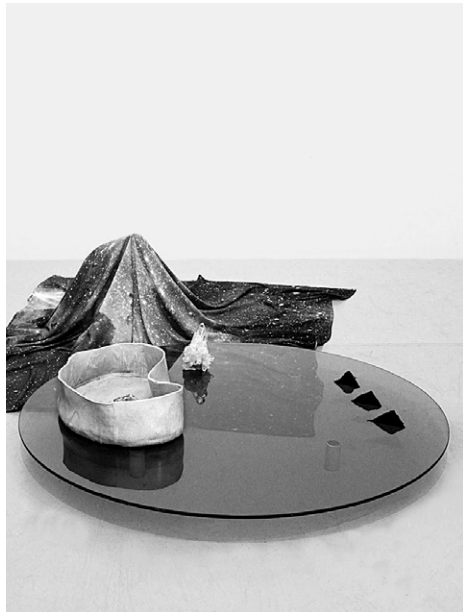

Fig. 5: Lena Dues, *Galaxy S9+*. Glass plate, galaxy fabric, rock crystal, celestine, glazed ceramic, metal, 2018

expression of a continuous search process and an exploratory approach to the behavior and aesthetics of materials. The interplay of control, planning, and letting go of control in the sense of following the material properties is central to this. I usually start by collecting a lot of a particular material, building up a kind of material cosmos, and conducting material studies (fig. 5). My favorite materials are silicone, plaster, glass, epoxy and polyester resin, ceramics, bismuth, gallium, minerals, home-grown crystals, water, and plants.

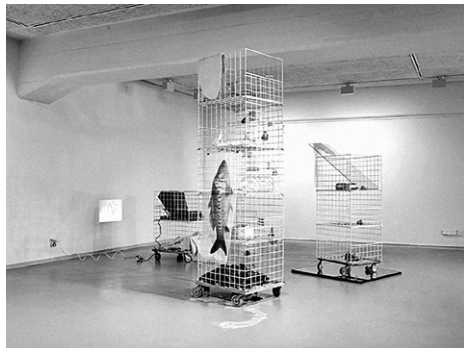

Fig. 6: Lena Dues, *holistic device*. Three-part installation, mixed materials, 2019. *Artificial landscapes in domestic habitats*, Kunstverein Ahlen

• NiS You have mentioned several times in our conversation how important the sculptural character of your work is to you, i.e., your engagement with the medium of sculpture. How would you describe the relationship between control and the stubbornness of the medium in your installations, sculptural works, and prints?

• LD Compared to my other works, in *Auturgy of Carbamide* I have significantly reduced the sculptural element and given more space to the idea. In general, however, I always take the material as my starting point. What material fascinates me, what appeals to me, what feels good? I call this an aesthetic exploration of everyday life. I am interested in materials and surfaces that are present in certain subcultures or on Instagram, for example. My work is an

• NiS What is most important to you in your work? How would you describe your artistic practice?

• LD I am interested in transformations, in becoming and growing, in changing consistencies, colors and forms, and in the relationships between large and small, between naturalness and artificiality. The spatial installations are often reminiscent of laboratory situations in which the boundaries between natural processes and artificial manipulation become blurred. Scientific images such as anatomical drawings, chemical structural formulas, astrological unicodes, or symbols of subcultures are often part of the installations and graphic prints, which are accompanied by narratives between scientific fact and fantastic invention (fig. 6–7).

• NiS You have worked a lot with minerals and crystals. Where do you see potential and inspiration, for instance for creation and design?

• LD Crystal structures are regular, very stable atomic or molecular lattices that can serve as models for the construction of stable structures (materials engineering, architecture, medicine, design). An example is diamond, the hardest natural substance. What is interesting in this context is the tendency of atoms to arrange themselves in a specific crystal lattice. In steel processing, for example, the formation of particularly stable crystal lattice structures is achieved by adding alloying elements, thereby fine-tuning the character of the steel. Similarly, crystal structures that can be adapted to specific requirements and environments could be systematically investigated for design strategies.

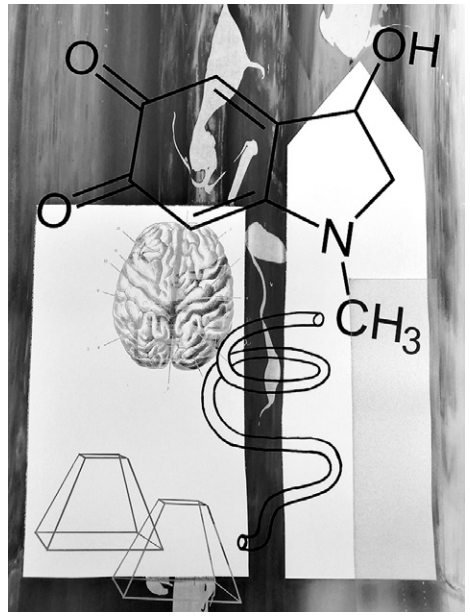

Fig. 7: Lena Dues, *Adrenochrom*. Screen print on Bristol carton 308g/sqm, 50x70 cm, series of 40. Part of the Alumni screen print edition of Kunstakademie Münster, 2021

• NiS Even though your work was in the stone display case, it was connected to the exhibition as a whole. What larger connections do you see between your work and our exhibition?

• LD I can think of three connections off the top of my head. First, there is the exhibition's approach of presenting big questions that affect entire ecosystems on a small scale, which could perhaps be called »scaling.« This is also a central idea of my approach. Maybe that's where my fascination with the aquarium theme comes from, because again, you're putting an ecosystem in a small box and then into a different environment. It was similar with the cloud in the exhibit.

Second, I liked the 3D printing of the stones. The interplay between nature and artificiality and the reproduction of objects that exist in nature are themes that play a role in my work. The fact that the stone could also be seen as a natural stone in the display case reinforced this effect: it seemed like a strange »glitch« in the matrix.

Fig. 8: Lena Dues, CH_4N_2O. Glass plate, urea, dental impression, petrified oyster, mineral (pyrite, quartz), polyester resin, 2019. *Materialisations*, thenationalmuseum, Berlin

And finally, I see the general concept of the exhibition as a unifying factor. By seeing itself as a public platform for the interweaving of theory and practice, it also rethought the concept of exhibiting. The showcases, which normally protect the exhibits from the visitors, have opened their doors and the objects are not located in optimally air-conditioned rooms; instead, visitors are allowed to interact with them. This is also where my works come in,

as it interacts with its surroundings and sometimes even depends on changing climatic conditions, e.g., an installation with gallium that melts at temperatures above 27.5° Celsius in the exhibition space, or salt crystals that form during the exhibition and disintegrate when the humidity increases, or water that evaporates and leaves lime patterns (fig. 8).

• NiS Finally, I'd like to know where you stand now. It's been almost two years since you participated in the exhibition. Do the questions from the exhibition still concern you today? Do you still work with urea?

• LD Yes, the urea hasn't left me yet. What I find very exciting at the moment is the question of residues. So what happens when the urea forms larger crystalline structures and then dries? Then you can pulverize it again and make a solution out of the powder and grow crystals out of that solution. It's like an eternal cycle (fig. 9).

Fig. 9: Lena Dues, *Petrification*.
Mixed materials, 2021

But I find the structures that dry out after the waxing particularly exciting because they also offer new possibilities to work sculpturally. I actually plan a little more and exercise more control. At the same time, I have turned my attention back to more everyday aesthetic phenomena and am planning more sculptural works in this direction, such as a column piece.

• NiS Thank you so much for giving us this glimpse into the Lena Dues universe.

SCATTERED DIFFUSION

Natalija Miodragović in conversation with Maria Mascha Kobylenko

Intermezzo 2

• Natalia Miodragović: Your interactive performance *Scattered Diffusion* used the ceiling of the rotunda as projection screen and aligned visitors' bodies on the floor, stretching the collective auditorium space of TA T's amphitheater into the exhibition space of *Stretching Materialities*. The video of the performance shows how focused participants were on collecting information with their phones, almost dancing while generating sounds, and then lying down or sitting together on the floor. There is a sense that the visitors are a community. Was there a similar sense during the mediation sessions with exhibition visitors, which you also conducted?

• Maria Mascha Kobylenko: To contribute to the tangibility of the liveliness of matter, I developed the interactive audiovisual performance *Scattered Diffusion* with sound artist Siamend Darwesh during the course of the exhibition (fig. 1). It was an invitation for visitors to explore the materialities of the exhibition and to create a shared audio-visual experience. Theoretical reflections by philosopher Jane Bennett on New Materialism were played back as auditory fragments. The installation consisted of two parts: sound and moving images. Four microphones were installed at four stations (stone collection, *hanbok*, willow, cloud) to create four different sound layers. Visitors generated the sounds, for example, by touching the haptic stone box, the silk of the *hanbok*, or the rattan and willow structures. The sound layers overlapped and were translated into an atmospheric soundscape. In parallel, microscopic material recordings were collected by visitors in the exhibition room and sent to the live video manipulation software Touch Designer. Through microscopic magnification, pumice stone transformed into a crater landscape, and tiny grains of sand appeared as large as rocks. The video recordings were also layered and manipulated by the sound input. The video transmission was projected onto the central round white fabric of the light element on the ceiling, conceived as the reminiscence of the elevator that used to lift animal bodies into TA T's amphitheater from the rotunda, the exhibition space. Now, the floor surface of the rotunda became the auditorium. With pillows scattered throughout, more than a dozen visitors could sit or lie underneath the projection.

Fig. 1: Interactive Performance *Scattered Diffusion* at TA T

To answer your question about mediation: for me as a visual artist and VJ focusing on experimental animations, the role of mediator for spatial narratives and performances during *Stretching Materialities* was a lot of fun. However, the interactive, audiovisual performance is also a form of mediation for the exhibition topics. My biggest challenge during the mediation was the diversity and complexity of the topics, which brought together various disciplines, ways of thinking, and approaches. To better convey the larger context, I tried to communicate in a playful manner. The notion of »touch« was a major component in breaking the barrier between visitors on the one hand and the material and knowledge on the other. In this sense, it was unlike a conventional, classical exhibition that prohibits touching. I also used many (counter-) questions to encourage active engagement on the participants' part. This often led to enriching exchanges, as this method also brought strangers into conversation with each other. The sense of establishing community was important, also for the performance. Such exchanges could be simple questions like »What do you associate with a stone?« or »Can a stone be a memory carrier, like a USB stick?«

• NM You say that the complexity in mediating originates in interdisciplinarity?

• MMK This multidisciplinary collaboration provided insights that usually occur behind closed doors, in laboratories, industry halls, archives, or collections in research facilities or development departments. The visitors showed great interest and were enthusiastic about discussing current topics in the context of the exhibition. There were also skeptical reactions from visitors who did not understand how the individual areas were connected. We were gradually able to resolve these issues thanks to mediating conversations and explanations. Participants included different people from *Matters of Activity*, students, artists, people from the Charité campus stumbling upon the exhibition, as well as larger groups and interested individuals. Participants from the *stretching senses school* were also often present, conducting various field studies. → Intermezzo 5, 343 Additionally, there were many different events like the *Berlin Science Week*, *Club TransMediale (CTM)*, and lectures and performances, which further enriched the exhibition.

BODY MATTER LABS

Natalija Miodragović in conversation with Lara Ladik

Intermezzo 3

• Natalia Miodragović: Your Master thesis, *Tapping into the matter edge. Cultivating bodily attentiveness with the non-human as part of Stretching Materialities* at the Institute for European Ethnology at Humboldt University in 2023 is tied to the exhibition *Stretching Materialities*. The objects on display in the exhibition invited visitors to actively engage, encouraging them to explore and train their perception by observing how they might alter along with their environment throughout the interaction. Could you elaborate on the role of the body and bodily awareness in this context?

• Lara Ladik: As a movement researcher, body practitioner, and cultural anthropologist-in-becoming at the time, my Master's thesis evolved around the question how body awareness in the exhibition space could foster our perception of our shared interdependence with materials, exploring them as living entities. Are we able to trace their aliveness within ourselves, beyond habitual visual observation and intellectual understanding of (the biological and physical laws governing) how materials interact with their surroundings? What kinds of ontologies are being shaped? To pursue these questions and ultimately develop a mediation proposal with scores for visitors, I first engaged in my own movement explorations. An example of this auto-ethnographic endeavor is the dive into the »willow nest.«[1]

Through such auto-ethnographic explorations, and later also extensive ethnographic material gathered from participants of workshops called »Body matter labs«[2]—which I co-facilitated with professional dancers Jozefien Beckers and David Kummer, and where body perception was placed center stage—I investigated how negotiating with material can align with the notion of sympathy.

• NM What is sympathy?

• LL While growing up and navigating life, we learn—hopefully—to behave empathetically towards one another and the living world at large. However, empathy, as philosopher of science Vinciane Despret understands it, has its limitations. It risks being only one-directional: I can be empathetic towards another being, but in doing so, I position it as something different and outside of myself. Like an object, the other can be seen empathically, but my empathy does not enable the other to return to me as a subject (Despret 2004, 128).

I find the experience of sympathy when I allow myself to explore my body as a plane of potentiality, as I had experimented inside the willow nest: when I perceive myself as matter *relating* to other matter seemingly outside of my body, and *respond* (with movement or feelings, for example) instantaneously when *perceiving* that relation. Just as in the willow nest, where I had no goal or intended direction in sight, I simply followed, vertebra by vertebra, the points of contact with the willow branches. I not only learn to *feel* within myself what initially seems outside of myself, but I also—and this is where it seems to become an art of perception—learn and train myself to sense the quality of the matter (dense, hard, bendable, with soft air chambers in-between) and myself in responding to those qualities at the same time.

As philosopher Mark Eli Kalderon suggests, »Sympathy is what makes the extra-somatic present in haptic experience. Thanks to the operation of sympathy, we experience from within what the extra-somatic is like.« (Kalderon 2018, 51)

Experiencing not only the extra-somatic, but also the immediate response gives me an understanding of overcoming my preconceived duality between myself and the material world. Could this approach help us grasp the aliveness of our surroundings and our inter-beingness with it on an embodied level? To feel this in *responding*, are we becoming reciprocal extensions to our material surroundings, becoming-with-another?

Fig. 1: Inside the willow nest

Integrating body and movement awareness into a mediation proposal that invites visitors to engage through playful exercises has proven, once more, not only to be beneficial in preventing the phenomenon of »museum fatigue« within exhibitions. An approach like this keeps visitors engaged with the topic and may spark conversations arising from their focused and intimate experiences with the exhibition (Løppenthin et al. 2022).

Those who were open to exploring the various objects in *Stretching Materialities* while tuning into body sensations reported feeling engaged, awake, curious, and inspired, with sharpened senses. They became more considerate of themselves and their actions, understanding that perception builds upon participation. Ultimately, it also fostered a sense of connection among visitors who were initially strangers to one another, and to the »living material« itself.

Negotiating. Auto-Ethnography
Lara Ladik (Excerpt)

Timid at first, curiously listening, I slowly crawl inside and through the willow nest. This tunnel-like space, composed of large meshes, feels stable yet bendable under my weight. I am the larger, undeniably noticeable particle, dense and clumsy. The material composition of my body—water, bones, cells, breath—meets the surface of the willow branches. The bends in the mesh press into my flesh and resist my bones. It resists me—or do I resist? I move and soften around points of contact. The empty spaces of the mesh become tangible. They are my refuge where I can hook in a finger or a foot. Resting, intertwining, softening.

The web as a whole yields under my weight. »Natalija! What if it breaks?!« I exclaim, worried about damaging this beautiful sculpture that has grown over months with the work of many hands. »If it breaks, it breaks! It's about negotiating,« she reassures me. I try and synchronize my movement with my breath, extending into the structure. I release movement into the willow, receiving it back as I withdraw. Breathing with willow—I'd never thought about it. I learn to move forward through the meshed space with ease, finding tiny, precise movements within my body, adjusting vertebra after vertebra along the willow structure, seeking only the next point of contact, not thinking about my final destination.

Like invertebrate creatures such as worms, I test my immediate environment, then move along. A new sensation arises: I mold into my material environment, accurately, moment by moment. My movement originates from the matter that I meet—not from a visual destination that my body follows with a biomechanic response.

Imagining the fluids inside my body dropping down, as if they were pouring around the bends of the willow gives me a sensation of density within me. It's a fluid density contained only by the breathing barrier of my skin. What probably seems like an absolute still point from the outside is full of shared micro-movements, full of shared life, between me and the willow. My eyes are the last to follow—enjoying the new perspective they've been moved into. Suddenly, gravity feels different: the denser the structure on which I rest my leg, the more it supports me, the lighter my leg feels. I feel light-bodied—in parts, at least. My micro-movements matter.

1 See *Negotiating* excerpt below.
2 »I can only come into my own in community with other living matter,« cited from Andreas Weber, biologist and philosopher.

ANTENNAE—WILLOWALK

Natalija Miodragović

Intermezzo 3

The group »Antennae,« formed by Chloé Lee, Samuel Perea-Díaz, and VanTa during an art residency at the *stretching senses school*, chose to bodily expand—»stretch«—experiences by interacting with willow branches. The three multimedia artists initiated this artistic research encouraged by myself, architect and researcher, and anthropologist Yoonha Kim. We were interested in unfolding the willow's sonic dimension that we discovered during the preparation of the exhibition *Stretching Materialities*. The artist group created two artworks that explore sensing in motion and sensing walks in Extended Reality (ER), an emergent field employing Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (XR) technologies.

In conversations with artist and architect Samuel Perea-Díaz, he describes *Willowalk* as a listening journey, a process of weaving sonic terrain. For Samuel, listening opens up the in-between, the intersecting spaces of being with others, both human and more-than-human. He posits that listening requires sonic participation and engagement with our surroundings, which implies understanding the epistemologies and pluralities that constitute the built environment.

Fig. 1: *Willowalk*. Listening Workshop at Charité Campus

Willowalk is a form of extended listening that involves grasping a willow branch with the hand, extending it next to the thumb, and gently inserting it into the outer ear. This allows one to hear the sound transmitted through the willow's material from the outside world to the inner ear. It introduces audiences to a unique method of sensing spaces by using a temporary sonic antenna as a prosthesis to extend the senses on their bodies.

Two coupled artworks produced by the Antennae group negotiate how immersive technologies engage with virtual and/or actual walks for the senses. *Antennae* is a VR artwork that brings audiences close to hearing bone conduction by amplifying sound via two willow branches attached to a VR headset (Meta Quest 2) and playing it back in rendered delayed light impulses and capturing sounds.

Fig. 2: *Willowalk*. Listening Workshop at Charité Campus

Willowalk is a listening workshop, a guided journey weaving sonic terrain with listening walkers exploring the surroundings of the building of Tieranatomisches Theater (TA T) on the Charité campus in Berlin. We began with a sound walk, using the architecture as a score to follow, and walked as a group from the exhibition space to the outdoors. Shortly after getting outside of the building, we focused on the surrounding sounds while working in pairs—one with closed eyes and prioritizing the oral, while the other concentrated on other senses. During a collective walk while listening through the willow branches, we gently scratched surfaces, followed later by the *Antennae* experience in the amphitheater. The listening workshop concluded with a group discussion. Walking shapes listening as a collective experience through our sharing of individual sensations and impressions that disclose different sonic materialities in the actual and virtual spaces. The transformative potential of this artistic intervention into sensing spaces is evident in the feedback received from participants who expressed a newfound appreciation for the sonic aspects of the environment they perceived:

> With worlding in mind—the sound walk makes you »hear« the sun, the dry grass, and soil on the Charité Campus. The ecologies of birds, humans, machines (air conditioning), material perturbation (sealing the soil with bitumen), and flow.
>
> I feel more connected to my oral senses.
>
> Today I had the chance to have branches instead of arms and listen to the rocks on the floor. I trusted a complete stranger to be my eyes. The words in my brain took a short vacation. When they came back all tamed and smiley, they told me I should let them go away more frequently. Gracias por la transmisión.
>
> The soundwalk was really ear-opening.
>
> Humans are so soft to touch and hearing. They come across as a pretty large organically shaped jelly mass with pressurized membrane (skin) as an interface.

(Quotes from different participants' feedback on the listening workshop *Willowalk*)

THE SPATIAL OBSERVATION OF THOUGHT

Natalija Miodragović in conversation with Jean-Daniel Berclaz

Intermezzo 3

• Natalija Miodragović: For the finissage of *Stretching Materialities*, you conducted a one hour artistic performance in the amphitheater of Tieranatomisches Theater (TA T), entitled *L'Attente* (The Awaiting/Anticipation). Why did you choose the space of the amphitheater?

• Jean-Daniel Berclaz: There were already many ideas in the exhibition space. I wondered what else could I do here? I'm not someone who looks for or brings a lot of materials. I'm more interested in another language. And my own material is also perhaps a kind of silence of solid materials. I found that this theater is already an installation in itself, it's already a work, it's already a structure. It's already there.

When I was told about the history of this place, the main story was that of the elevator going up and down. In fact, we were gathered in the space of the dissecting room, where animal corpses used to be placed on a big plate for dissection. The animal is a mirror, a reflection of ourselves—because an animal does what we do, it walks and eats. There's not much difference between them and us, we are animals, and when you open the inside, there's a liver, the kidneys, we all have the same system. It's like a car engine, you need all its parts, and the system needs fuel. When we talk about the power of an engine, we talk about horses—horsepower.

• NM The horses, the animals, were the essence of the transport and war industry—an animal machine, an enhancement of the human body. The TA T building, one of the first Veterinary Anatomical Theaters, was built during the horse pest pandemic. Until then, anatomical theaters were built for the knowledge of the human body. I am interested in your process of conceptualizing this performance. In French, the title *Attente* translates into waiting but also into anticipation: attentive waiting.

• JDB When one is downstairs, in the rotunda, one is in the very structure of this theater. Basements are always laboratories. In a family setting, if there are children who want to make music, we put them in the cellar in order not to wake everyone up. Somehow, all this music down there is like a laboratory, in search of something. The floor above is the explanatory aspect of the laboratory. As an artist, I cannot explain anything scientifically, but I can consider the meaning of a place—that is my science. The amphitheater reminds me of my time in art school, where I loved to visit life classes, drawing living models—people instead of animal corpses. It was also a kind of amphitheater, with an almost religious feeling. Everyone has a sketch pad, and they draw. You hear only the sound of the pencils and other than that—there is silence. And that is the image I have of the moment when the professor would come to give a lesson and was waiting for the animal. The elevator with the animal would rise and everyone would be there, waiting for the professor to speak. I wanted to recreate that scene.

• NM The very moment is essential. What role does time play in your work?

• JDB I've been thinking about anticipation, waiting for a result, waiting for an action. When you take the train for an hour, you are no longer in the city. In general, when you look out of the window, you're out of the city, you've crossed the forest, and you're somewhere else. You haven't done anything, and you're waiting an hour to arrive. I did an internet search for horses, and I found the sound of a horse galloping. If you loop the sound of a running horse, you loop, loop, loop—it becomes techno. At some point, you run with this expression; it provides a rhythm, and you follow it. It's like an engine, or a train. I edited the whole thing into a one-hour

loop. My timing for the performance was the music. I knew that when it stopped, the hour was up. And then I do what the audience does: wait for one hour. The act of waiting is that moment. I am in the same situation as the audience, I don't know how long we've been there, or if there are ten minutes or half an hour left.

• NM The amphitheater has a voluminous dome—a large space built specifically for thoughts, for learning and teaching. My logic as an architect is: if there is a space, there is materiality to be accommodated—the materiality of thoughts. You said that what matters to you is the spatial observation of thoughts: are these the audience's thoughts?

• JDB It is also the audience's thoughts because what I found interesting is playing on symbols. Like this silly sculptural object with the horse I installed. There was »symphony« there. In the center of the round elevator surface, I placed a round mirror that reflected the ceiling, on which I placed the small sculpture of a horse (fig. 1). The horse sculpture turned around and around, much like the horses on those tables used to, and the ceiling then turned with it.

• NM Alongside the VR technology experience we featured in the exhibition, this seems to be the ultimate analog experience, an action by an artist experienced in person. You had your mirror, your thoughts—your tech.

• JDB I also found a child's horse toy with small bells that I glued to the end of a broomstick. It has a wizard-like quality to it. The professors are in the field of magic because they explain things from another world. I think it's important to create a space of detachment between the person, the public persona, and the professor's persona. It's there, like a crystal ball within a crystal ball. You can even predict a bit of the future, anticipate. There are plenty of little cues like these that are small symbols but sufficient to shift your attention. Otherwise, you wouldn't stay captive. I'd say that's similar to music, much like the galloping horse becoming techno. And all of this is part of the broader picture. It's important to think of it as the window of a train. It's the window that makes you look outside. If there's no window, you won't look outside.

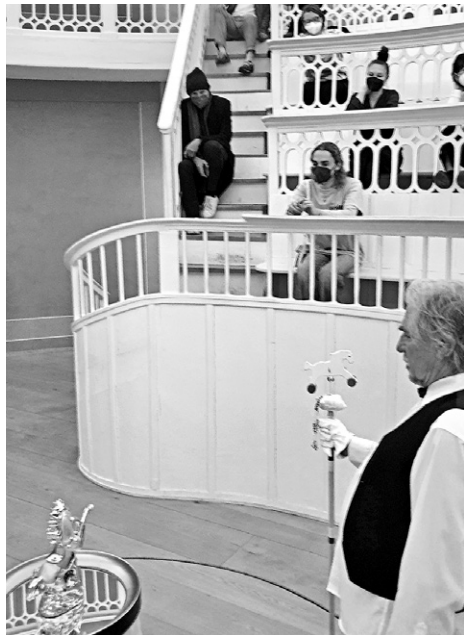

Fig. 1: Jean-Daniel Berclaz, *L'Attente*. Artistic performance in the amphitheater of TA T

• NM You have already said that you need tools to captivate the audience and bring them into the professor's reality. Were you captivated by the exhibition?

• JDB You made all these experimental objects out of willow. What I liked was the idea of it being based on resonance. You could hear sounds with objects, actual long willow branches, if you put them in your ear. I like that you could listen as if they were mobile phones, you could telephone to different spaces. And when you talk on the phone with spaces, a space responds to you by vibrating in another object. We were able to move around with something, a twig, and that is also a sort of management of space. The woven willow structures that you make from these same twigs are somehow solid; they are trivially transparent and solid at the same time. It is a solidity that both limits and delimits space—you can see through it, but it is also a boundary because you can see through it.

• NM Your ongoing project is *Le Musée du Point de Vue*, a museum solely within the personal realm; it is art without artwork. In this work, there are no objects at all. Is there a connection to *L'Attente*?

• JDB My *Point of View Vernissages* are more about the expectation we have of artworks. After all this expectation of the artwork at a vernissage, you leave immediately afterward. In the *Point of View Vernissages*, I consider that the exhibition space is always where you are. Everything you can see around you is the exhibition. So, the exhibition walls are the limits of your gaze. The walls lead to the museum hall. If the site is outside, your gaze goes much further. And then you have to find a place where things speak to you. First, you need a place with a political story, an issue, or something specific. The interest is also to point out something that people have never paid attention to; they always pass by it but never notice it. For me, it is a bit like easel painting. The artist goes with their easel, sets up outside, and paints. Similarly, the *Point of View Vernissages* are like an easel painting, and the audience creates the painting. I don't present myself as an artist. I have an artist's project, but I am just the museum director and curator because I chose the place where I put the museum. In absence of an artist, the audience does the artist's work. I have done a hundred of these events worldwide. It is really interesting because the audience initially wonders if there will be fire-breathing, acrobatics, or if someone will undress. But I do absolutely nothing. I simply dress properly because I respect the museum, so I am well-dressed. Everything is professional, and people suddenly forget everything. They are there, and they completely forget any questions they may have had. They leave enthusiastically, and they say, »Oh, it was fabulous.« You know, when you go to a vernissage, everyone hangs around the table with food and drinks. After all, why look at the art? They will say, »Merde, it is closing in ten minutes! I will come back to see the art another time,« and that's it.

IMMERSION
INTO THE MICROSCALE

Natalija Miodragović in conversation with Michaela Eder

Intermezzo 3

• Natalija Miodragović: Michaela, as a material scientist, the time you spent with us designers and exhibition-makers examining the materials we are working with was crucial for the project. Your knowledge of trees and fiber architectures in biology provided us with additional insights, particularly when it came to observing material properties at a microscopic level. You taught us where to look, how to observe, and introduced us to the practices and experiences of the natural sciences, such as using a microscope or preparing samples. This experience gave me a different sense of scale (such as the microscale) but also of time or pace. I found observation through the microscope to be quite a calming experience, offering a different awareness of time. This was my introduction to working in the lab. I have learned to appreciate working with matter in a focused manner at what one might call a microscale of events, and I found the collaboration between science and design to be very useful. I wonder, how useful—or useless—does it strike you as a material scientist?

• Michaela Eder: The useful- or uselessness depends on the viewpoint of both disciplines. The benefit for a designer can be the information about the microstructure of the raw material; at the same time, this information does not necessarily influence the process of »Gestaltung.« However, this is exactly what is useful to us: we obtain the information of what can (and cannot) be done with a given material. This helps sharpen our research questions related to material properties. The designers' experiments are particularly helpful for plant materials because of the huge diversity in material structure and properties, even within the same species or the same individual, since design experiments are typically much faster than studies at very small scales. In our research, materials science, we often focus on a very specific question. Yet, there is such a vast diversity of knowledge, and with each designer, architect, or humanities scholar who comes into the lab and wants to investigate their material, my knowledge of the diversity of structures and properties increases. Even though I do not use this knowledge directly, in the end, it contributes to my own research.

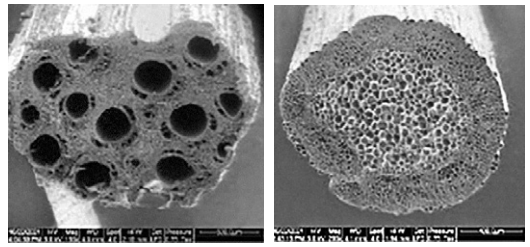

Fig. 1: Microscopic images showing the fiber structures of rattan (left) and willow (right)

• NM You were teaching us how to cut samples and observe them in order to understand the forces and practice of bending a willow twig, for example—the differences between its lower part, which is closer to the roots and soil, and its tip. As part of the same twig, these structures are both similar to each other and also radically different. As designers working with the material, we felt this in particular when bending the twigs. It was insightful to understand what had already been experienced or concluded while negotiating the forces in the twigs.

• ME What I found particularly interesting about this project was that you brought both willow and rattan into the lab, which have completely different growth patterns. When examining different sections, you can see where the differences lie—and this is essential knowledge (fig. 1).
❑ Process, fig. 23, 284

• NM Yes, they are completely different. Willow is a tree, and rattan is a palm, but they both possess properties of elasticity

and formability. This is more of a user-oriented description. When I mentioned that willow could be described as a local (European) bamboo, you disagreed, saying that bamboo belongs to the monocotyledoneous plants, as do the grasses, and that bamboos are not trees. However, both can be bent and formed. The elasticity of the material makes the local winds visible. Wind itself is invisible, but it becomes visible through its interaction with the environment. This kind of remote or delegated sensing is needed to understand complex processes like climate and urban dynamics. Wind can be seen—or rather felt—in the material because when you bend it, it reminds you of the wind bending the trees outside. This property comes from these bendable species and the landscapes they inhabit. You also mentioned that the majority of the material is actually dead tissue.

• ME The property and effects of this flexibility are due to the fact that your twigs of willow and bamboo were thin and had a high aspect ratio. On the living plant, they also needed to be flexible because, otherwise, they would just break in heavy wind, since the cross-sections weren't large enough. By contrast, if you look at the stem of a large willow—it's not flexible. In addition to the larger diameter of the stem, the material formed at the periphery is much stiffer and supports the crown. Flexibility of large stems doesn't make sense in this case since it would simply bend and fall over.

• NM Your reaction motivated me to learn more about the tree itself. After reading scientific papers on the subject, I now understand that the tissue that was once transporting sap eventually changes. As the tree grows, it becomes dead tissue and adopts a more structural function, whereas initially, its role was more infrastructural—transporting sap.

• ME Do you know how a tree grows? A stem grows both in height and diameter. The so-called apical growth takes place at the tip of both stems and branches. The cambium—a ring of meristematic cells, located between the wood and the bark—forms wood cells (xylem) toward the inside and bark cells (phloem) toward the outside.

As a tree grows, its diameter increases and so does the circumference of the cambium, ensured by cell division in tangential direction. Concerning the functions of the tissues, the xylem transports water from the roots to the shoots. Nutrient transport from the crown downwards takes place in the phloem. Additionally, the radial connection between cells is ensured by wood rays, also formed by the cambium. While the axially elongated xylem and phloem cells are derived from so-called fusiform initials of the cambium, the more isodiametric ray cells derive from ray initials.

After cell division, cell differentiation and thickening take place. Cells that need to be water-conducting must get rid of their cell content in order to be able to transport water quickly. This means that they die a few days or weeks after they are formed to become fully functional. The ray cells, responsible for nutrient storage and transport processes, remain alive. As the tree grows and gets older, not all of its cross-section is needed for water and nutrient transport. Transport only takes place in the outer part, the so-called sapwood, while the inner part, the so-called heartwood, is dead. The ray cells have died and in many cases this process of heartwood formation leads to a higher resistance against microbial degradation.

• NM Many designers in the Cluster actually conduct research on and with cellulose-based materials. Welcoming more designers into material scientific labs seems essential. Would you say that for these collaborations to work, it is crucial to understand that everybody is trying to contribute and tolerate what might be considered stupid questions?

• ME I would say it's not about tolerating, it is really about openness and the willingness to explore how this collaboration can lead to fruitful discussions. I believe it's not sufficient just to put scientists and designers together. They also need to connect with each other, which requires trust and respect. This trust is necessary in order to feel comfortable with asking any questions.

Fig. 2: Immersion into the hybrid willow yarn at Max Planck Institute of Colloids and Interfaces, Golm

• NM As an architect, this project is also about all the remote spaces connected to the research project at hand. You work at the Max Planck Institute of Colloids and Interfaces in Golm. The building in which the lab is situated is an important node in the network. I think that this building is unique in the sense that it houses microscopes, connecting you to other scales.

• ME It is unique because of the people who work there, because of what they think and what they do. Maybe coming back again to the benefits of working with designers, especially given the work you and Nelli Singer did, it was extremely inspiring to see that the knitting and entangling of your twigs with certain geometries allowed movement in different directions while restricting others by the presence of neighboring elements. My guess is that a materials scientist would not have come up with such an idea and would certainly not be able to realize it in such an aesthetic way. Structures and prototypes such as yours trigger our thoughts about what the interesting research questions are. What do we need to know to advance structures like that? With each of these experiments, we are also learning more about the material, and this is something we should not underestimate. I think this is one of the really important aspects for us. It triggers critical thinking in different directions. Also, we need the designers' speed of working! You are so quick compared to us. It's quite useful. But I guess designers also need to get used to our slow pace; we need to get used to each other. In the end, we benefit from collaboration. Seemingly useless interactions are, in fact, essentially useful.

THE TEXTURE OF TIME:
A Journey Through Stones, Touch, and Active Matter

Nina Samuel in conversation with Mohsen Makki

Intermezzo 4

The exhibition section Stretching Time—Researching Collections is based on the premise that different concepts of time, activity, and passivity of materials—questions about the relationship between time and matter—are embodied in collection objects. In order to explore and discuss these ideas, we conducted field studies in several of Humboldt University's collections. Among these, the Geological-Geomorphological Collection was particularly fruitful for exploring the relationship between time and matter.

Through numerous visits and conversations with Mohsen Makki, the director of the collection, weathering emerged as the conceptual core of this section of the exhibition and began to influence other parts of the show. Working closely with Makki, we discovered that stones are far from inert. Instead, they are incredibly active materials fundamental to life on Earth. The continuous cycle of rock formation and transformation, driven by plate tectonics, underscores their vitality. Despite the vast timescales involved, which are beyond human comprehension, rocks demonstrate an ongoing process of change that is essential to the life-sustaining mechanisms of the planet.

During this conceptual phase, a broader question emerged: how can weathered stones enhance our understanding of contemporary museums and their role in visualizing the passage of time? In addition, we explored how stones relate to the politics of time and whether museum objects share a similar time and memory structure with ruins, addressing key questions of ruin archaeology. We raised these and other questions during inspiring conversations with Makki and countless hours we spent in his collection, opening shelves and cabinets, touching a variety of rough and textured surfaces, and experimenting with our own hands.

Makki's research covers a wide range of topics, including the genesis and distribution of urban soils in Berlin, soil-based vertical farming in metropolitan areas, the interaction between soil and society, and geo-ecological solutions for rapidly growing cities. Geographically, his geo-archaeological investigations span regions such as Iran, Tajikistan, Uzbekistan, and Italy. His extensive expertise has provided invaluable insights for our exploration of the temporal dimensions embedded in museum collections and the living history they represent.

This preparatory interview, conducted three months before the exhibition's opening, not only inspired the selection of stones for the display case but also formed the conceptual basis for the design of the interactive and exploratory elements, as well as the VR environment planned in collaboration with Studio Above & Below. It also highlights the profound implications of understanding stones as active participants in the Earth's history and future.

Fig. 1: Drawer cabinets from the Geological-Geomorphological Collection of Humboldt-Universität zu Berlin

● Nina Samuel: One of the most exciting insights for me from our meetings in your collection was the importance of haptic knowledge in geography. Knowledge is always created by touching stones, by feeling surfaces. To me, this aspect seems to be central both to the selection of objects in the Geomorphological-Geological Collection and to geological knowledge in general. It could perhaps also be described as »implicit knowledge,« acquired over time and through connoisseurship, which cannot always be written down. It seems that the materiality of the stones also allows us to sense invisible processes that are inscribed in their materiality. What role does the sense of touch or the feeling of rock surfaces play in geological knowledge and collecting?

● Mohsen Makki: Geoscientists, particularly geomorphologists and geologists, believe that when we pick something up and physically engage with it, we connect with it and facilitate learning. This physical connection sets in motion several components of learning. Learning involves not only hearing and seeing but also feeling and smelling, and in geology, even tasting. You wouldn't lick the hand specimens in the collection today because they've been used by students since 1890. But a fresh rock is licked to test the salt content, for example,

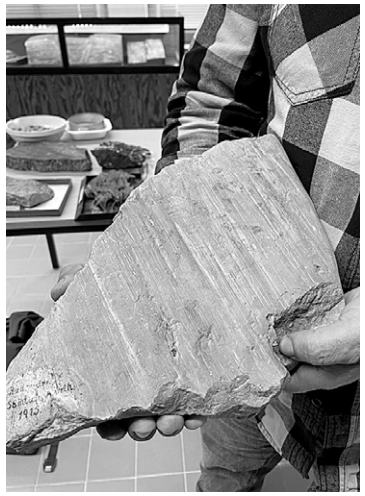
Fig. 2: Glacier cut from Rüdersdorf

or to reveal certain structures (e.g., microstructure or texture) that would not be visible in a dry state. So touch is the name of the game in geoscience. When you hold rocks in your hand, you can rotate them or look at them from a different angle with better light. Our objects are meant to be touched. This is reflected in the size in which most of them came into the collection—small enough to be kept in drawers from which they can be taken out at any time (fig. 1–2).

The Geomorphological-Geological Collection was founded in 1906 as a teaching collection. When Albrecht Penck (1858–1945) took over the management of the Geographical Institute in 1906, the history of today's teaching collection began. The aim was to use the material for didactic purposes and rather than collecting particularly valuable stones, it was about collecting as many ordinary stones as possible from the most diverse regions, specially cut into small hand pieces so that they could be easily stacked and as many as possible could be accommodated.

• NiS During my visit, I was also fascinated by Albrecht Penck's limestone with glacial striations (fig. 2). What role did the sense of touch play with this stone?

• MM Our students learn in the first semester that glaciers always have a direction in which they erode rock. A glacier grinds the rock in a distinctive way. By feeling, you can find out exactly which direction this is and how it combines with the traces of other stones that the glacier has taken with it, such as grooves and scratches. This stone comes from Rüdersdorf, near Berlin, and is made of limestone. At that time, glaciers were known from the Alps but not from northern Germany. Penck recognized from the »glacier scars« on this rock that there must have been glaciation in northern Europe as well. It was a groundbreaking discovery.


Fig. 3: Touch the object from the collection! You can feel the abrasive effect of the flowing water. The water has only smoothed the surface of the rock in one direction. You can feel that the surface is rough in the opposite direction

• NiS In this context, I would like to return to a second hand piece collected by Albrecht Penck in 1893 (fig. 3). Could we also speak of a special significance of haptic knowledge and the senses in this context?

• MM The sense of touch plays a central role in geology and geomorphology in general. In this example, the rock has undergone two processes, first solution weathering, where contact with water created a rough surface. Then it was placed in a relatively dry area where the wind blew mainly in one direction for about a thousand years. The surfaces touched by the wind were polished smooth. But the leeward surfaces remained hard. So you can brush in two directions, one is completely smooth—that's the direction of the wind. The other direction is very rough—that is the lee. So the sense of touch plays a very important role here.

Another example are ventifacts. They occur mainly in regions with little or no vegetation, such as deserts. Depending on the environment, the climatic conditions can be dry or cold deserts. Due to later climate changes, such as warming at the end of the Ice Age, ventifacts can also occur in areas where they would not occur today. For example, they are found in the moraine landscapes of northern Germany, which were cold deserts or steppes during the last ice age, the Weichselian periglacial. They therefore reveal a great deal about global climate history.

• NiS Our exhibition is about materials and their hidden activities. From a geological point of view, stones can also be described as active material, except that their activity is beyond the direct reach of humans or human perception. What do you consider to be the activity of stones?

• MM From an anthropocentric perspective, it may seem that rocks are passive, especially when only considering our short lives. However, geology and geomorphology show a cycle of rocks. A rock can originate from magma and reach the Earth's surface through plate tectonics. There it is weathered by exogenous forces and becomes sediment, which through diagenesis becomes solid rock. This solid rock moves back underground through plate tectonics. If it sinks deeper, it can be melted again by the melting process, anatexis. In short, rocks are always moving. Unfortunately, these movements are so slow for human understanding that people perceive them as solid, immovable, and unchangeable.

• NiS For the exhibit, we display a collection of eight different examples of stone weathering results (fig. 4–5). This display is curated not only to illustrate the perpetual cycle of stones transitioning from gravel to silt but also to provide a tactile experience for visitors. Thanks to our Haptic Box placed in the display case, visitors are able to physically explore and feel the textures of these weathered stones, making the natural process both visible and tangible. → Stretching Time, 224


Fig. 4–5: Different grain sizes of weathered rock: gravel, coarse sand

• MM Gravel has rounded edges and a certain minimum diameter. In addition to gravel, there is coarse sand, fine sand, silt, and clay, which vary in grain size. The determination of these sand types is based on grain size, which is determined using special equipment and tables.

These substrates show different weathering conditions. For example, when a mountain disintegrates due to exogenous forces, coarser pieces, such as rocks, are formed first, which fall from the mountain and break. Over time, the pieces become smaller, depending on erosion factors such as wind, water, and frost.

Some erosion processes in nature create a natural sorting process. In fast-flowing waters, it's more likely to find stones and gravel, while in slow-flowing waters, such as the River Spree, grains of clay and silt are more likely to be found. In calm waters, clay particles can be deposited when the water is still. Over geological time, various substrates, such as sand washed in by rivers, can compress already deposited clay layers and squeeze water and solutions out of the clay (diagenesis). This pressure can lead to the formation of new clay, completing the endless cycle of new rock being formed from weathered rock.

• NiS What time periods are we talking about?

• MM How long this cycle takes depends on the climate. For example, chemical weathering is very slow in the desert and much faster in central Europe. In areas such as Central Asia, however, a layer of sediment such as loess can become several meters thick within a thousand years. In the ocean, it generally takes several hundred thousand years for a meter-thick layer of clay to form.

• NiS The sand shown in the exhibition also has a very current political dimension, especially when we think about how we deal with our resources.

• MM Sand may be a scarcer resource today than oil or natural gas. Modern society is experiencing a construction boom that requires large quantities of a special type of sand. This sand must consist of angular, non-rounded grains because these have better mechanical properties in cement. This special sand is usually found on beaches or in sand pits. However, the quantities available are insufficient. Some Arab countries and small island states need large quantities of sand to expand their territory by reclaiming land from the sea, as in the case of the Palm Islands in Dubai. Desert sand, with its round grains, is not suitable for this purpose as it does not offer sufficient stability. These circumstances have led to a global shortage of sand on the market, making it increasingly difficult to obtain large quantities. This in turn has led to the emergence of numerous criminal structures. In some cases, sand is mined in India or Morocco by digging large holes in sandy beaches. This sand is then illegally transported to Asia or Europe.

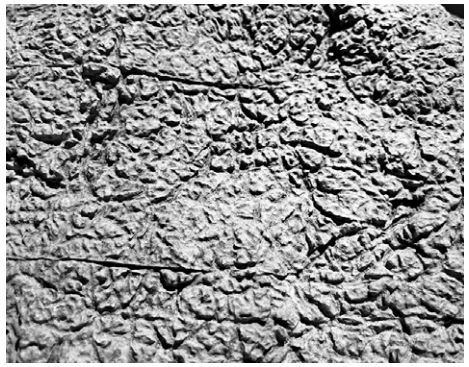

Fig. 6: Malm limestone, chemical-biological weathering, etched by plant roots; detailed view

• NiS Sand is ultimately formed by very long weathering processes. In this sense, sand can also be described as »pulverized (or ground) time.« Weathering processes are very present in the Geological Collection. To what extent can weathering be described as a driving force behind the collection strategy or as a collection criterion?

• MM Geography, especially geomorphology, is the study of the Earth's surface. As soon as a rock is placed on the Earth, it begins to weather. The dominant weathering factors vary from place to place in the world. We are therefore interested in changes on the surface at the macro, micro, and meso scales. Weathering is the basis for landscape design. In a discourse about a changing planet, weathering is one of the most important processes. Without weathering, there would be no diversity of color in the landscape. Anything exposed to the environment is subject to weathering—not only rocks but also all objects in your home.

• NiS Weathering not only varies in intensity but there are also very different types of weathering. In the exhibit, for example, we have chemical-biological weathering (fig. 6). Here we have a dominant pattern: a kind of network of sinuous lines. How did this pattern form on the rock?

• MM The irregular patterns you see are imprints of roots and traces of organisms from the Malm/Jurassic period. The Jurassic period was characterized by abundant plant life and the rock was a layer of mud. The pattern therefore comes from both plant growth and the tracks of worms, especially earthworms. Despite the decomposition of the organic parts, these imprints have been preserved to this day through specific processes and layering.

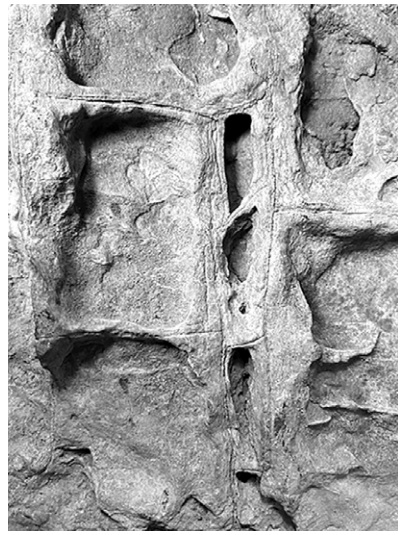

Fig. 7: Zellendolomit, solution weathering by ice and snow; detailed view

• NiS In addition to chemical-biological weathering, physicochemical weathering, also known as solution weathering, plays an important role in your collection (fig. 7). Can you explain these processes in more detail?

• MM The surface clearly shows the long-term effects of wind, water, and snow. Snow, in particular, has a major effect on the structure of the cavities. The meltwater is acidic and reacts with the rock, creating a flour-like weathering material that accumulates in the holes. In dry periods, such as summer, the wind intensifies this effect by blowing away the fine material and enlarging the hole. As the snow continues to fall, more snow collects in these holes, intensifying the process. Once weathering has begun, it is accelerated by the cavities because water can stay longer in the holes. Such forms often occur when the rock's surface is in the shade, as snow and water have more time to settle in the cavities.

• NiS There is another structure in the stone that I find interesting, these vertical, very fine lines (fig. 7). How did they form?

• MM These structures that can still be seen in the rock today, these straight vertical lines, were there before solution weathering. They are old cracks that have closed again. The rock was once broken and then »welded back together,« so to speak. And then it came to the surface and that is where the carbonic weathering began.

• NiS There are many examples in the collection of rocks that have been newly formed and grown through weathering processes. Take calcite (fig. 8), for example, how was it formed?

• MM The vast limestone landscapes of the Alps have been exposed to the constant action of rainwater for millions of years. This process, known as carbonic weathering, occurs when water, a weak acid, reacts with the limestone. Some of the limestone is dissolved. The dissolved material is transported by the flowing water. Carbonic acid weathering creates cracks in the rock that widen over time. Water flows along

these cracks, transporting the dissolved material and widening the cracks further. If the water enters an underground cavity, it can cause precipitation or the formation of lime (calcite minerals) under altered conditions, creating new forms underground. A long and slow weathering process eventually leads to the formation of such forms that look like flowers.

Fig. 8: Calcite

• NiS This reminds me of the processes that form the so-called desert roses (fig. 9).

❑ Exhibition Views, fig. 21, 140

• MM Calcite and desert rose are both formed from an aqueous solution. The difference is that calcite is formed in cavities in solid rock, while desert rose is formed in cracks in the soil, i.e., in loose material. High temperatures cause the soil material to shrink, creating cracks. Groundwater infiltrates these cracks and forms crystals (gypsum or barite) over time. The climatic conditions of the desert, especially the power of osmosis, are ideal for these processes. Desert roses (also known as sand roses) only become visible when the soil erodes. Calcite, on the other hand, is discovered when rocks are fractured or quarried, as in karst caves.

• NiS So while desert roses are formed by cracks in the loose soil, there is another type of cracks that also plays an important role in our exhibition. You can see them clearly here on the weathered limestone (fig. 10). How do these cracks form and how do they close again?

• MM These cracks, usually perpendicular to one another, are caused by tectonic movements of the Earth, such as great pressure or the rising of magma. They serve to equalize pressure. Perpendicular cracks are particularly common in limestone. As water seeps in, these fine cracks grow larger over time. This rock shows that a change to a warmer climate took place. The climate became warmer with more rainfall. The upper layers of the rock were heavily weathered, while a solution of bicarbonate accumulated in the cracks. Such solutions that accumulate on the rock can precipitate new minerals and thus close the cracks. In this way, a kind of coating forms on the rock and the cracks are closed by secondary materials.

Fig. 9: Desert rose

Fig. 10: Weathered limestone

• NiS Another particularly fascinating case of cracks in rocks is that of folded alpine limestone (fig. 11). Again, the focus is on cracks and their closure. In what way?

• MM Imagine the rock is like an accordion. When tectonic forces pull it apart, the white zigzag lines you see here become straight. These lines were originally cracks in the rock filled with secondary minerals such as calcite (white). Then pressure was applied from both sides and the accordions or layers of rock were squeezed together. Vertical shears formed in response to this tectonic pressure. Minerals and rocks were reshaped and new structures (folds) were created in the rock. All the white lines were once cracks running parallel to each other. This whole process may have taken millions of years.

• NiS Finally, we come to the subject of slag (fig. 12). This is also one of the moments when the Anthropocene theme appears in the exhibition.

• MM Humans have changed seventy percent of the Earth's surface. We see farmland and settlements everywhere. Even in the high mountains, humans are building houses and spreading civilization. But the foundations of the Anthropocene were laid much earlier. As early as the Bronze Age, 6000 years ago (4000 BC), humans began to produce new materials, such as ceramics. Take a medieval hand piece from the region of Harz. They tried to extract different metals or glass. Ultimately, it is a waste product of man. The production process of stone is involuntarily similar to that of volcanic rock. First everything is melted at a high temperature, then it cools down quickly and this creates these degassing holes in the rock. These rocks are called anthropogenic rocks or anthropogenic formations. They are dangerous to the environment because they can also contain pollutants such as heavy metals (e.g., arsenic and cadmium) that can be released when in contact with water. These stones can also weather badly due to an oxidation process and rust formation (see yellowish spots on the stone).

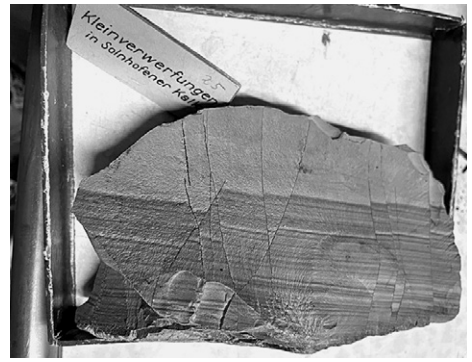

Fig. 11: Minute fractures in Sollnhofen limestone: cracks are immortalized in the rock as line drawings

• NiS From the perspective of your discipline, how would you classify the concept of the Anthropocene?

• MM The term is interesting and worth discussing, especially between geologists and geographers. Geographers such as Eckart Ehlers argue that humans have had a significant impact on the Earth, for example through changes in climate and water systems. Some geologists, however, insist that we are still in the Holocene, and see the Anthropocene more as an epoch within the Holocene. Some propose the atomic bomb tests of the 1950s as a marker

for the Anthropocene. It is also debated whether human influences from the Bronze Age, such as extensive deforestation for the production of ceramics and metals, could serve as a marker. The question of whether the Anthropocene is a new chronostratigraphic series or a new climatic stage within the Holocene remains open and is the subject of interdisciplinary debate.

Fig. 12: Slag from metal production

Fig. 13: Mohsen Makki with the collection of anthropogenic soils of Berlin

• NiS And the Anthropocene also plays an important role in the collection.

• MM Yes, we have set up a new collection area for anthropogenic stones and are also training people outside the university (fig. 13). This is especially interesting for Berlin as a former industrial city. All the big companies/industries, such as the metal industry, produced a lot of material, and the waste materials were also distributed in the soil. As soil scientists, we have to find out what materials are present in the soil and what effects they have on the environment. To this end, a table has been compiled for Germany that lists about 130 different anthropogenic formations that can also be found in the soil of Berlin and the surrounding area.

• NiS Dear Dr Makki, thank you very much for this inspiring interview.

BREATHING STONES: Exploring the Intersection of Microbiology, Geology, and Conservation

Nina Samuel in conversation with Anna Gorbushina

Intermezzo 4

This interview explores Rochus Blaschke's scientific photographs, which have been incorporated into *Stretching Materialities* over the course of the exhibition to reveal the hidden biological and geological processes that shape stone surfaces. In conversation with Anna Gorbushina, an expert in microbiology and geology, we explore how Blaschke's images reveal the often invisible interplay between microorganisms and stones. This discussion highlights the ways in which these interactions contribute to the transformation and life cycles of stone, deepening our understanding of materiality and its often hidden, dynamic, living aspects.

• Nina Samuel: You mentioned that in your research there are interesting points of intersection with Rochus Blaschke's work, particularly in relation to organisms and damaged stone surfaces. Could you elaborate how your research overlaps with his and what initially led you to study the relationship between biological organisms and stone surfaces?

• Anna Gorbushina: It's fascinating when you come across unexpected overlaps between different research fields. My interest in stone surfaces began during my PhD, which focused on the colonization and destruction of marble monuments in the Crimea. This research, funded by the Volkswagen Foundation in the early 1990s, looked at microbial colonization of stone surfaces, particularly marble. At the time, many projects were being funded in Germany to study stone degradation, particularly of monuments, in collaboration between different disciplines such as geology, materials science, conservation, and biology.

Initially, stone research focused mainly on the physical and chemical properties of materials, but the biological element began to appear in the early 1990s—the idea that microorganisms living on the surface of stones play a critical role in their degradation. Specifically, I looked at how organisms colonize these surfaces, what conditions encourage this growth, and how it affects the stone over time. For example, the marble surfaces of monuments such as those in the Mediterranean, the Acropolis, and the Crimea were colonized by microorganisms such as fungi and lichens. These organisms were actively altering the stone, causing significant changes such as pitting. These biological factors were largely ignored until we (a group of collaborating PhD students in the lab of Wolfgang Krumbein) brought them into the discussion.

• NiS It's interesting that you bring up the biological aspect of stone degradation, because the idea of a »defect« on a stone surface could be interpreted in many ways. Are these microorganisms seen as defects of the stone, or are they simply a natural part of the stone's evolution?

• AG That's an important question, and it touches on a shift in the way we look at these processes. Traditionally, people have seen these organisms as harmful—defects that need to be removed. But from a biological perspective, we now realize that microorganisms are a natural part of life on Earth. Wherever there are suitable environmental conditions—temperature, moisture, sunlight—microorganisms will thrive, and this includes stone surfaces. So while they may appear to be a »flaw« from a conservation perspective, they are actually an integral part of the stone's life cycle. They are part of its natural transformation process.

In the past, especially in the early twentieth century, the immediate reaction to the discovery of microbes was to eliminate them. But today we recognize that microorganisms are vital to many processes. In fact, they're often necessary to maintain the health and stability of ecosystems. The same is true for stone surfaces. Microbes can contribute to patination—a natural aging process that may not significantly alter the structural integrity of the stone but still adds to its aesthetic and historical value. So rather than seeing these organisms as purely destructive, we can see them as part of the stone's ongoing narrative.

So, the question of whether these organisms are »defects« depends on the perspective. From a biological perspective, they're a natural part of the environment. From a conservation perspective, they may be seen as something that needs to be managed to preserve the appearance or structural integrity of the stone. It's important to recognize that these organisms are part of the natural history of the material, and sometimes we need to work with that reality rather than against it.

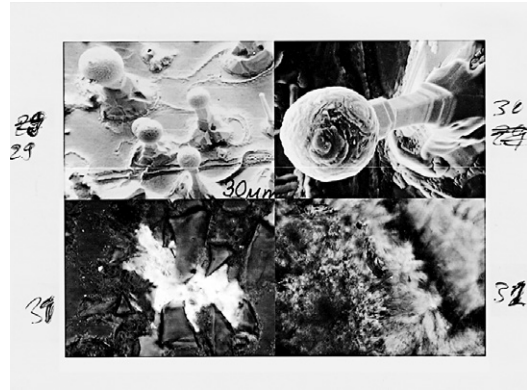

Fig. 1: Rochus Blaschke: Microscopic investigations on surfaces. Images from his lectures. Not dated

• NiS You've done a lot of work in the conservation field as well, particularly with restorers. How have biological insights shaped the way we approach the preservation of stone monuments today?

• AG This interdisciplinary approach has been crucial. When I taught microbiology to conservators between 1997 and 2007, a large part of my work was to raise awareness about biological growth on stone surfaces. Many restorers at that time were not trained to recognize microbial colonization. They might have noticed discoloration or surface changes but didn't realize these were often caused by biological activity. My goal was to help them develop the ability to identify these structures so they could differentiate between harmful microbial growth and normal patination. This was part of shifting the vocabulary and the mindset in conservation.

For instance, in museums, we can manage the environment to prevent microbial growth on stone surfaces. By controlling factors like temperature, humidity, and light, we can prevent the development of damaging biofilms without resorting to chemical treatments. This approach helps

preserve the stone in its natural state, whereas chemical treatments—like those commonly used in the 1990s—can sometimes cause more harm than good. They might kill the existing organisms, but they can also create conditions that encourage more aggressive microbial colonization in the future or lead to the formation of resistant strains.

• NiS Let's now talk about the photographs in the exhibition. They are electron microscope images from the 1980s, and they seem to offer a very detailed view of stone surfaces. ❑ Process, fig. 21, 282 Could you tell us what you, as a scientist, see in these images? What can they tell us about the interaction between stone surfaces and biological growth?

• AG These electron microscope images are incredibly valuable for understanding the microscopic interactions between biological organisms and stone surfaces. What immediately strikes me is the presence of biofilms on the stone. A biofilm is essentially a layer of microorganisms that forms on a surface, and in these images, you can see how the stone surface is covered by these biological colonies. These organisms form a matrix—a kind of slimy layer—that helps them adhere to the stone and interact with its mineral structure.

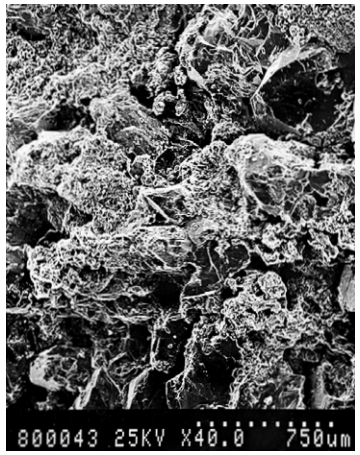

Fig. 2: Rochus Blaschke: Bacterial colonization on stone surfaces. Not dated

In one of the images, you can see individual microbial cells, which appear as small, rounded structures. What's interesting is that although these cells are relatively small individually, over time and while accumulating, they can have a significant impact on the stone. They secrete enzymes and acids that break down the minerals in the stone, leading to surface pitting and other forms of degradation. Beneath the biofilm, you can still see the crystalline structure of the stone, but it's clear that the biological layer is actively altering the surface.

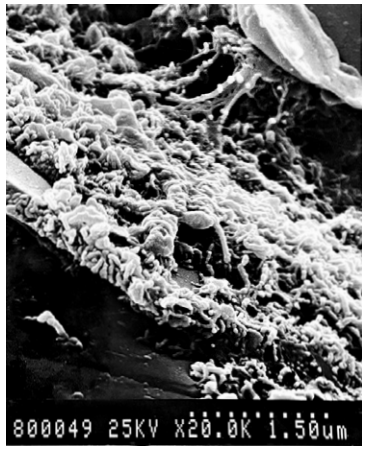

Fig. 3: Rochus Blaschke: Bacterial colonization on stone surfaces. Not dated

• NiS You mentioned that microorganisms on stone surfaces »breathe« in a way similar to our own metabolism. How does this process affect the stone?

• AG Yes, these organisms breathe and produce CO_2, which reacts with water to form a weak acid. This acid can etch stone surfaces such as marble, contributing to their deterioration over time. Respiration, like combustion, releases energy but in controlled steps. In these organisms, this process can take place inside or on the surface of the cell, affecting the stone.

• NiS So, in a sense, the stone surface itself »breathes« as long as it's colonized by living organisms?

• AG Exactly. These microorganisms allow the stone to interact with the atmosphere, essentially making the surface a living, dynamic system. The images reveal how deeply integrated the biofilm is—it's not just a layer on top of the stone but something that is directly linked to the mineral composition. The biofilm creates its own microenvironment, distinct from the surrounding air, which can accelerate chemical reactions such as mineral dissolution and further alter the stone's surface.

• NiS Does the process of preparing these samples for electron microscopy—like chemical treatments—affect what we see in the images? Would the stone look different without these preparations?

• AG Yes, the preparation process definitely affects the appearance of the samples to some extent. In the 1980s, when these images were taken, electron microscopy required the samples to be chemically fixed. This means that the biological material had to be stabilized with substances such as glutaraldehyde, which essentially »freezes« the biofilm in place. After fixation, the samples were dehydrated and then dried using critical point drying, which helps to preserve the structure of the biofilm while removing water.

These chemical treatments can slightly alter the appearance of the biofilm, but they were necessary to obtain such detailed images. Without them, the biological structures could collapse or disintegrate during the imaging process. So while the images aren't a perfect representation of what the biofilm would look like in its natural state, they still provide a very accurate view of the relationship between the biofilm and the stone.

Today, we use this traditional method along with more advanced techniques such as cryo-electron microscopy, which allows us to image biological structures without chemical fixation. In cryo-microscopy, the sample is rapidly frozen, preserving its natural state without the need for chemicals. However, this method has its own limitations, such as the fact that the samples can't be preserved for future study.

• NiS It sounds as if these microorganisms are deeply integrated with the stone surface, almost symbiotic. Is it possible to separate the biofilm from the stone, or are they too interconnected?

• AG It's difficult to separate them, especially if the biofilm has been on the stone for a long time. The organisms penetrate the surface of the stone and become part of its structure. In some cases, we can use weak acids to dissolve the stone without damaging the biological material, allowing us to study the organisms in isolation. For example, when studying coral reef organisms that have burrowed into the carbonate matrix, we can dissolve the carbonate to reveal the organisms' structures.

But in most cases, the relationship between the biofilm and the stone is so intertwined that it's hard to separate them naturally. The organisms don't just sit on the surface—they interact with the stone, changing its properties and contributing to processes such as weathering. The stone provides nutrients and physical structure for the organisms, while the biofilm changes the stone's surface in return. It's a symbiotic relationship in many ways.

• NiS You've mentioned weathering several times, and I'd like to delve deeper into that concept. Can you explain what weathering is and why it's important for both ecosystems and stone surfaces?

• AG Traditionally, weathering has been viewed primarily as a chemical or physical process. For example, rocks can break down as a result of exposure to water,

wind, or changes in temperature. Over time, the minerals in the rock dissolve or fracture, leading to the formation of smaller particles that eventually become soil.

However, we now know that biological organisms, particularly microbes, also play an important role in weathering. These organisms produce acids, acidic poly-saccharides, and enzymes that help break down the minerals in rocks, accelerating the weathering process. This biological weathering has been a critical component in the development of life on Earth, helping to create the soils that support plant life.

In terms of stone surfaces, weathering can lead to both degradation and transformation. For example, on monuments or building facades, weathering can cause the surface to erode, which can be seen as damage. However, weathering also contributes to the natural aging process of stone, creating patinas, mineral deposits, or a combination of the two that add to the character of the material. In this sense, weathering is both a destructive and a creative force—it breaks down existing structures but also creates new ones.

• NiS This idea of weathering as being both destructive and creative is really interesting. It reminds me of a discussion we had about the relationship between decay and growth. How do you see this relationship, especially in the context of stone surfaces?

• AG There's definitely a close relationship between decay and growth, especially when it comes to biological interactions with stone surfaces. On the one hand, microorganisms contribute to the decay of stone by breaking down its mineral structure. They produce acids and other compounds that dissolve the minerals, leading to pitting, erosion, and other forms of surface degradation.

Fig. 4: Rochus Blaschke: Microscopic investigations on surfaces. Images from his lectures. Not dated

At the same time, however, these organisms can also contribute to growth. For example, certain microorganisms can precipitate minerals, leading to the formation of new crystalline structures on the surface of the stone. This can happen in environments where minerals are dissolved in water and then precipitate as new layers on the stone. So while the organisms are causing decay, they're also creating new growth through biomass or in the form of mineral deposits.

This process is most evident in the formation of patinas on stone surfaces. A patina is a thin layer that forms on the surface of stone as a result of weathering, and it can be both a biological and a chemical process. Microorganisms contribute to the formation of the patina by interacting with the minerals in the stone, while environmental factors such as moisture and temperature help to shape its development.

In many ways, decay and growth are two sides of the same coin. The decomposition of the stone creates the conditions for new growth, and this cycle is a natural part of the stone's life. It's also an important aspect of the aesthetic and historic value of stone monuments. A well-weathered stone surface can tell a story about the passage of time, the environmental conditions it's been exposed to, and the organisms that have lived on it.

• NiS I'm also interested in the idea of »self-healing« stone that you mentioned earlier. Could you elaborate on this concept and how it relates to both natural and human-made materials?

• AG The concept of self-healing stone is a fascinating one, and it's something we see in both natural materials like stone and human-made materials like concrete. In natural stone, self-healing can occur through the process of mineral precipitation. For example, when cracks form in a stone surface, water can seep into the cracks and dissolve minerals from the surrounding stone. As the water evaporates, these minerals precipitate out and fill the cracks (e.g., with very fine micritic calcite), effectively »healing« the stone. This process is slow, but it demonstrates that stone is not a passive material—it can respond to environmental changes and repair itself over time.

In human-made materials such as concrete, the concept of self-healing has been applied more deliberately. Self-healing concrete is designed to repair itself when cracks form. This is achieved by adding bacteria to the concrete mix. These bacteria remain dormant until cracks form and water penetrates. When exposed to water, the bacteria are activated to produce calcium carbonate, which fills the cracks and restores the integrity of the concrete. This technology is particularly useful in the construction industry, reducing the need for repairs and extending the life of buildings and infrastructure.

The idea of self-healing materials, particularly those enriched with functional biofilms, is part of a wider trend in materials science to create materials that can adapt to their environment and repair themselves. This has important implications not only for construction but also for conservation, offering new ways of preserving stone monuments and other materials without the need for constant intervention.

• NiS Talking about human-made materials: You've also touched on the idea of anthropogenic stones—stones that have been altered or created by human activity. Could you explain what you mean by this and how it fits into your research?

• AG Artificial stones are stones that have been significantly altered by human activity, either through direct intervention or through processes such as pollution and industrial activity. One of the most common examples is concrete, which is essentially an anthropogenic stone. Concrete is made from natural materials such as limestone, sand, and gravel, but it's mixed and shaped by humans for use in construction. In cities like Berlin, anthropogenic stone is everywhere—on building facades, streets, and monuments.

The term Anthropocene has been used to describe the current geological epoch in which human activity is one of the dominant forces shaping the Earth's surface. While the term is still debated in some circles, geologists have identified specific markers—such as the presence of certain isotopes in sedimentary layers—that reflect the impact of human activity on the planet. This concept is linked to the idea of anthropogenic rocks, because they are a physical manifestation of our impact on the Earth. These stones are not just altered by humans—they are created by humans and play a significant role in shaping our environment.

In my research I'm particularly interested in how these anthropogenic stones interact with biological organisms. Just like natural stone, man-made materials such as concrete are subject to biological colonization. Microorganisms can colonize the surface of concrete, leading to the same kinds of weathering processes that we see in natural stone. In fact, some researchers are exploring ways to harness these biological processes to improve the durability of

concrete and other materials. For example, by encouraging certain types of microbial growth, we can promote the formation of protective biofilms that protect concrete from environmental damage.

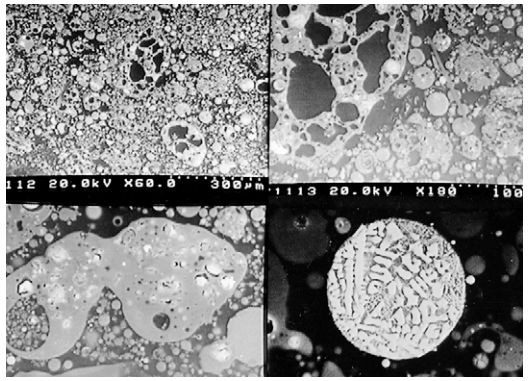

Fig. 5: Rochus Blaschke: Investigations on microscopy. Images from his lectures. Not dated

• NiS With growing awareness of environmental issues such as climate change, do you see a role for stones and minerals in addressing these global challenges? Are there ways in which stone can contribute to environmental sustainability?

• AG Absolutely. Rocks and minerals play a crucial role in regulating the Earth's climate, particularly when it comes to carbon sequestration. One of the most exciting areas of research at the moment is the concept of »enhanced weathering,« where certain minerals, particularly silicates, are used to capture and store carbon dioxide (CO_2) from the atmosphere. Silicate minerals naturally react with CO_2 to form stable carbonate compounds that effectively sequester the carbon and prevent it from contributing to climate change.

The challenge is that these processes are slow. In nature, the weathering of silicate minerals takes place over geological timescales, so it's not a quick solution to the problem of rising CO_2 levels. That's why researchers are looking at ways to speed up these processes, for example by grinding silicate rocks into a fine powder and spreading it over large areas of land or sea. This increases the surface area available for chemical reactions, speeding up the process of carbon sequestration.

In addition to enhanced weathering, there's also potential for using biological processes to capture carbon. Certain microorganisms, particularly cyanobacteria, are able to fix carbon from the atmosphere and convert it into organic matter. These organisms can grow on stone surfaces where they contribute both to the weathering of the stone and to the capture of CO_2. While this is a promising area of research, it's important to note that these processes alone will not be enough to solve the climate crisis. They need to be part of a wider strategy that includes reducing emissions and switching to renewable energy sources.

• NiS That's a crucial point. While stones and minerals have immense potential for environmental sustainability, they can't do it alone. We need to form an active partnership with them, a symbiotic relationship. Thank you for sharing your expertise—this conversation was truly inspiring.

• AG It's been a pleasure to discuss these topics with you. There's so much to explore in the interactions between biology, geology, and conservation, and I'm glad we had the opportunity to discuss these together.

ABOUT CLOUDS, ROBOTS, AND THE SEA
Thoughts on the Aesthetics of Metabolic Formations, Biodiversity, and New Ecologies in Art and Design

Panel discussion with
Babette Werner, Anne Duk Hee Jordan, and Clemens Winkler

Intermezzo 4

Following Claudia Blümle's invitation to contribute to the exhibition project at TA T led by Object Space Agency (OSA) in 2022, art and visual historian and curator Babette Werner addressed the exhibition's overarching topic from a practice-based and theoretical perspective. In her research and practice, Werner explores process-based and inter-media art and design practices at the intersection of technology and ecology, dealing with time, space, and transformation. Her lecture »About Clouds, Robots, and the Sea – Thoughts on the Aesthetics of Metabolic Formations, Biodiversity, and New Ecologies in Art and Design« discussed the notion of an ecological aesthetic by specifically analyzing links between visual representations of metabolic formations, biodiversity, and new ecologies in the shape of clouds, robots, and sea ecologies within the realm of art and design practice and theory.

The selected case studies within the context of the early 1950s until today were analyzed through the lens of transience and material relations. The discussed artworks were mainly entangled with or stem from art and science research collaborations such as Otto Piene's *Sky Art* and *Weather Project* (1973) at MIT, *E.A.T. — Experiments in Art and Technology's Pepsi Pavilion* (1970), as well as Hans Haacke's *Weather Box Series* (1963/64), Fujiko Nakaya's atmospheric cloud and fog sculptures, projects by the New Mineral Collective[1], founded in 2012 by Emilija Skarnulyte and Tanya Busse, and more-than-human contributions by Andreas Greiner[2] and Hicham Berrada,[3] as well as immersive sea ecology installations and robotic works by Anne Duk Hee Jordan and Clemens Winkler's cloud apparatuses, to name just a few. The lecture was followed by a performative talk to which Werner invited visual artist Anne Duk Hee Jordan as guest speaker and design researcher Clemens Winkler.

1 New Mineral Collective, Emilija Skarnulyte and Tanya Busse. https://www.newmineralcollective.com.
2 Andreas Greiner, TOCCATA FOR PYROCYSTIS FUSIFORMIS, A PIANO PIECE INITIATES NATURAL LIGHT, grand piano, dark room, Pyrocystis fusiformis, seawater, developed in cooperation with Sunlay Almeida Rodriguez, 2014. https://www.andreasgreiner.com/works/toccata-for-pyrocystis-fusiformis/?/=chronological.
3 Hicham Berrada, Presage, Tranche, 2007–ongoing, chemical landscape evolving in a glass tank, light. https://www.hichamberrada.com/portfolio/presage-tranche.

• Babette Werner: My first question to both of you is: What aspects are especially challenging in your artistic research practices working with non-human agents, specifically diverse species, robots, and environmental conditions such as clouds and sea ecologies, with which you engage in your work? And secondly, I would like to know which new areas you would like to explore by means of opening up to sense otherwise.

• Anne Duk Hee Jordan: As a visual artist, I find myself engaged in solitary research, delving extensively into the realm of insect and beetle sexuality and the intricate auditory processes governing their sound production. Unlike the auditory structures familiar to us, some of these insects exhibit unconventional placements, with ears situated inside the mouth or protruding as external tentacles. These unique adaptations dictate both their auditory reception and sound emission methods, forming a key focus of my research. It requires a profound understanding of how insects, beetles, and other beings operate, extending beyond the confines of our human perspective. Embracing a holistic approach, I seek to absorb insights from various entities within the realm of entomology, fostering a reciprocal learning experience that transcends our anthropocentric standpoint.

• Clemens Winkler: Yes, reciprocal learning, which might give us new aesthetic experiences of abstract societal questions today, such as how to deal with complex climatic phenomena, is also at the core of my practice. My interest in acting with clouds as non-human agents extends over several years and involves collaborative efforts, including the ongoing teamwork evident throughout the *Stretching Materialities* exhibition. Here, I'd like to zoom in and draw a connection to the concept of embodying non-human actors in the microcosmos, like in Duk Hee's description of insects, especially in my interest in microbes composing today's atmosphere, capable of sensing weather, and also living and thriving in clouds. When asked about my favorite cloud-dwelling bacteria, I often think of Pseudomonas syringae, a plant pathogen that resides in clouds and influences the phase transition of water. This bacterial activity, especially its role in transcontinental rain patterns, captivated me early on and allowed me to collaborate with the field of aerobiology, environmental sciences, and climate engineering for the cloud installation here.

• BW One aspect that stands out when discussing your work is the seamless transition from the macroscopic to the microscopic worlds—and back again. This thematic thread is evident in many of your pieces, Duk Hee, in mixed-media environments like *Making Kin* and your edible landscape project *Into the Wild*. It was also highlighted in the exhibition *Der Wurm. Terrestrisch, Fantastisch und Nass* at Urania in 2021 (fig. 1), which showcased a multimedia installation with a substantial entrance to a diverse world. This entrance provided an immersive experience, creating a zoom-like immersive sensation as viewers could enter and engage with the artwork.

Fig. 1: Anne Duk Hee Jordan, *The Worm: Terrestrial, Fantastic, and Wet*. Site-specific room installation, mixed media. Urania Berlin e.V., 2021

• ADHJ The creation process involved crafting an entrance resembling a door, signifying a worm's beginning and end, and maintaining a consistent design. Advancing towards the bottom of the worm led visitors to a darkened space, illuminated to highlight various worm species existing on a microscopic scale. Central to the installation was a notably giant worm, approximately fifteen meters in length, suspended from the ceiling, alongside the Olavius (a minuscule deep-sea worm measuring only nine millimeters in circumference). The Olavius, known for its sulfur symbiosis, provided valuable insights into the dynamics of symbiotic relationships in our daily lives. In addition to the immersive experience, we infused it with an element of playfulness, acknowledging the challenges posed by the COVID-19 era, where material exchange and collaborative work faced stark constraints. This consideration was manifested in the design, inviting interaction with a torch and facilitating encounters with various worm species. Collectively, these elements allowed participants to delve deeply into the microscopic world of these organisms, enhancing the overall engagement with the installation.

• BW You've probably already observed that a cloud above our heads is forming as we speak. Collaboration is intrinsic in artistic research installations and artwork, wouldn't you agree, Clemens? The collaborative nature of artistic research installations requires an exchange with diverse sources, including engineers and natural scientists. How does this dynamic unfold in your cloud project, especially through your diverse collections of the cloud findings on the wall, like these microscopic images of dust particles and contributions from microbiology, meteorology, geology, and educational sources? With the experiential nature of the cloud, could you elaborate on your primary objective in navigating its complexities and grappling with the concept of ephemerality and shapelessness?

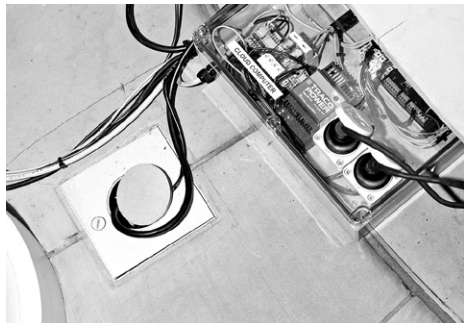

Fig. 2: Clemens Winkler, *Cloud Computer*, TA T, 2021/22

• CW Observing atmospheric, meteorological, and biological processes, the effects humans have on them, and the challenges for microbial life in for-humans extreme environmental conditions inform my practice in art, research, and design. It might start at a lower level, tracing life on minerals in the dust from a desert here in the exhibition space, up to untraceable climatic conditions around this exhibition space. Therefore, this cloud as part of a collaborative practice involves discussions with associated researchers in the field of Climate and Environmental Sciences but also with students here in the space about recreating structures seen in water vapor, or the sky, and in front of our bodies on cold winter days, and how this might be transformed into new experiences. In dealing with indeterminacy and shapelessness, I have collected scaled-up material models hanging from the ceiling, grown samples by airborne microbes, video installations on climate fiction, interactive VR work, up-to-event-scores and re-enactments on these protocol sheets, up to the chance of taking a direct breath from the visible cloud. This collection acted like an immersive track, but it also inserted a technique of irreversibility into the continuous process of cloud formations. It allowed me to orientate myself and led to consistency in my practice of sculpting clouds.

• BW I would love to delve deeper into knowledge sharing and how this sharing works for you. What do you do with your data about the climate, microbiomes, or the visitors? And who can participate in all the data you collect? (Clemens stands up and takes a sample with an air-biome collector from inside the cloud.) What are you doing right now, Clemens? Could you explain the underlying concept of this performative process to the audience?

• CW Certainly, I can perform the action as we continue discussing. This performance involves capturing reactions akin to fingerprints left in the air. If we removed our breathing masks right now, each person in the room would contribute a unique fingerprint to the air in this space. The accumulation of these imprints, particularly in a controlled environment like this conservatory, raises questions about the interplay of humidity, bacteria, and the decay of objects. It delves beyond the visible, encompassing residual body particles, body moisture, and heat, released—whether intentionally or not. Beyond the immediate focus on COVID-related sensitivities to air, this device I hold here in my hands, typically used in clean room laboratories for measurements, provides a unique perspective on the intricate activities transpiring in our environment, offering a glimpse into the potentially rich tapestry of narratives and dynamics in how we aestheticize air at present. Used in new, creative ways, it also shows me another way of dealing with practices of formless and ephemeral media—to dive into its consistencies and compositions through sympathizing with a microorganism. This might shed light on the whole history of the system by empathizing with it and exploring how it has developed its characteristics.

Fig. 3: Clemens Winkler, *Enveloping Atmosphere*, TA T, 2021/22

• BW Could you let us know more about your experience with more-than-human co-creation by »liberating the material« in the sense of »empowering« and »capturing« it?

• CW The focal point of my work, as showcased here, involves filtrating water collected during the recent stormy rain a week ago. The rain becomes a dynamic element, allowing us to revisit—indoors—the moment of its occurrence through this vapor. The data emanating from the droplets reveal the vapor's will and inherent dynamics, shaping my perspective as if I were sculpting the vapor. It's an appreciation of the freedom inherent in materials, a moment where I step back and observe, similar to how I approach clouds. Water is still one of the most unclassifiable materials we have on Earth. This reflective stance prompts consideration of how to intervene or depart from the conventional methods of contemporary design, especially in Western traditions, fostering a more sustainable and open-ended approach.

• BW Both of you appreciate the nuanced environment surrounding our

installation. The cloud is integral to the exhibition, interacting with everything within its purview. By allowing it to be unleashed and freely manifest itself here, the cloud becomes an interactive element in the exhibition space, engaging visitors who then saturate it with their own breath. Could you elaborate on the specific question or delve into the laboratory process involved in the design?

• CW The investigative process at TA T has led us to the development of a microclimate in the center of this podium, which we observe in its current state. The circular nature of the rotunda, capturing circulating elements in the wind (museum objects, visitors, and former residues), has resulted in the accumulation of dust particles. As we sit here, we find ourselves within an agglomeration of these particles, prompting ongoing reflections on navigating and understanding this distinctive microclimate. Here, if we read the installation as an atmospheric lab-in-the-making, observations of this cloud come through aerobiological and intra-machinic perspectives—Earth Learning and Machine Learning, I could call it. Intra-machinic is a term from art historian Ina Bloom drawing on Karen Barad's notion of intra-action. Above this cloud layer, you can experience up to 50° Celsius and 10% humidity right now, which prompts considerations of novel climate experiences here.

• BW Specifically concerning themes I explored in the lecture, I am curious about your perspectives on ecological aesthetics, sustainability inquiries, and the artistic production process. Additionally, I am interested in understanding your stance on collaboration, the reuse of materials and objects, as well as the repetition and documentation of a medium or idea in the context of art making.

• ADHJ Certainly, in my work, as you introduced in *Making Kin 1 and 2*,[4] there's an emphasis on incorporating clusters and sculptures into various pieces. Rather than creating entirely new elements, I focus on making models and strategically placing them in different environmental installations, considering how they can complement, and integrate into, existing compositions. Notably, the robotics I construct predominantly employ old materials, underscoring my commitment to repurposing rather than relying on new resources. The core concept is innovative, but the materials carry a history. In this approach, I draw inspiration from the work of Hans Haacke and Andreas Greiner, who you both mentioned in your talk, Babette. Haacke is a pioneering artist whose contributions from the 1960s and 70s remain relevant today. Haacke skillfully engaged with aesthetics and artistic terms, influencing how his artworks unfolded. Another artist who resonates with my practice is Andreas Greiner, a friend and former classmate. While our focus aligns on similar topics, we diverge in our expressions and material choices.

Fig. 4: Anne Duk Hee Jordan, *Making Kin*, installation view (detail), Kunsthaus Hamburg, 2020

• CW Working with leaking and weathering objects, surfaces, and materials made me focus on environmental factors rather than internal functions, making us subject-objects. I think that often, countering environmental changes in conventional ways leads to the challenges of the Anthropocene. We cannot avoid exhaustion from co-forming a cloud — including the pre-installed heating system here and the approach of redirecting river and rainwater into the building, nucleating on historical dust particles as well as the residues that we brought to this room. While these elements are exhaustive infrastructural residues, to me, they are, simultaneously, wondrous formations of clouds—signs of contemplation and hope. This contemplation extends to the observations of external elements, such as pollen and dust, infiltrating the space we discussed earlier. You mention repetition, which is crucial, and it prompts us to delve into the evolving nature of our practice, offering space for introspection and the development of openness and an attitude. When the entire exhibit relocates, a new phase of testing and results emerges for me, possibly initiating a fresh cycle of research. Each perspective in different places contributes to the rich tapestry of our collective understanding.

• BW Let's now open the floor for audience participation. We welcome your questions, comments, or ideas, aligning with the overarching theme of knowledge sharing prevalent in this exhibition. Feel free to share your thoughts or pose questions, and let's make this a collaborative and enriching conversation.

• Claudia Blümle: The focal point of the question seems to revolve, for example, around rendering the invisible visible (Paul Klee) and exploring how it integrates into our consciousness. I invite both of you to delve into the concept of ghosts—those emergent agents or remnants that transform into tangible entities. This notion introduces the idea of ghosts not merely as observable or perceptible but as living objects. Considering the historical context, ghosts resonate not only in the media, which inherently captures the echoes of the past, but also in transforming robots into entities that embody the essence of ghosts. This intriguing connection may align with the captivating climatic sculptures present in our surroundings. I encourage your insights on this fascinating interplay between visibility, history, and the living essence of objects.

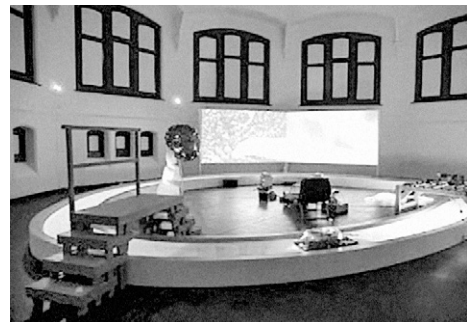

Fig. 5: Anne Duk Hee Jordan, *Making Kin 3.0*, site-specific installation, KIOSK, Ghent, Belgium, 2021

• CW Reflecting on the concept of ghosts evokes a sense of sudden manifestation as a correspondent to me, almost like in a theater play, when dust clouds tell us something about historical events, while influencing the future. Your question might link to Walter Benjamin's idea of the »angel,« not seeing history as a linear progression but as a series of ruptures, discontinuities, and unresolved tensions which continue to haunt our presence and future through »ghosts.« In sculpting and staging atmospheric events, I explore the cloud not only as a metaphor or material medium but especially its activity as a trans-historical motif. The comprising images and material objects collected from the air might link to »unresolved histories« residing in dust bunnies coalescing into new tangible airborne forms with moisture and opacity. Yet, when viewing this amalgamation of the cloud in the exhibition space right now in certain light conditions, a ghostly entity

4 Anne Duk Hee Jordan, Making Kin, 2020–2022, https://dukhee.de/projects/2020_MakingKin.

materializes, transcending the mere aggregation of dust particles, no? I see another aspect here in connection to Babette Werner's question on what is happening with our collected data from the research process. There is a certain spookiness involved because we think we're just doing something systematically over time. Sooner or later, by not fully acknowledging purpose or utilization while measuring the air and the clouds around us, questions of ownership, economics, and legal issues haunt us. Who holds the rights and the testimony of these events in the future?

• ADHJ Certainly, the notion of a ghost is multifaceted. Traditionally, it embodies a soul or an elusive presence that eludes direct perception, sparking a quest for its existence. This concept varies from the spectral entities portrayed in Stephen King's films, such as *The Shining*, where haunting narratives unfold, leaving an indelible mark. In the realm of my work, the idea of the ghost takes on a different dimension. It involves making visible the imperceptible, a pursuit of rendering tangible the unseen. Unlike the mysterious and potentially untrustworthy specters of horror stories, the entities I engage with, such as beetles or bacteria viewed under a microscope, are tangible and reliable. I endeavor to amplify our perception of these unseen entities, expanding our vision to embrace the invisible aspects surrounding us. Thus, exploring the concept of ghosts becomes a process of rendering visible the trustworthy and often unnoticed elements, inviting a broader understanding. In my creative pursuits, there may be moments where I, too, engage in a form of self-ghosting.

• CB Regarding ghosts, there's an intriguing historical anecdote tied to the advent of photography. In the early days, there was an attempt to capture and make visible the invisible, speculating that photography could bridge science and the supernatural, creating a connection to the past. This anecdote comes to mind, and it sparks the idea of speculation in the information Clemens might gather from our breath today. So, I'd like to pose a rather vague question about the role of speculation within both of your artworks.

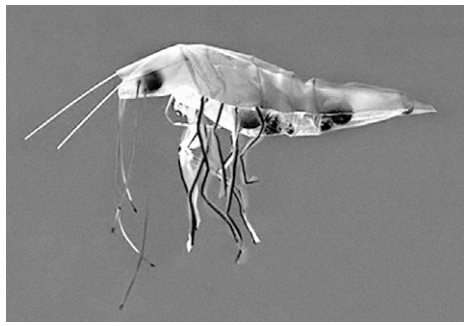

Fig. 6: Anne Duk Hee Jordan, *Water Crab*, detail, 2017–ongoing

• CW Drawing connections to the past via media, like imagery, aligns well with the concepts of my studies in Speculative Design at the Royal College of Art in London. In this exploration, breaking out of established narratives and language is crucial, allowing for the spillage of information, which might be framed as supernatural, as you said. Measurement accumulates as a mode of storytelling, and storytelling plays a vital role in speculating about the collected findings.

• BW Many thanks for this insightful discussion on the notion of ghosts to address the interplay between visibility, history, and the living essence of objects regarding the attempt to capture and make visible the invisible. My research resonates with your thoughts in the sense that I address the practice of (re-)staging process-based art as a media-reflexive curatorial and archival strategy to make the invisible artwork visible again. The framework for this is the notion that (re-)staging—understood as an extended sculptural genre—can be used at the interplay between memory and imagination. I understand the process of (re-)staging as a continuum between prioritizing the immaterial, like an experience or concept, and emphasizing the material in the sense of reconstruction, sometimes thoughtfully mapped out by the artist for future (re-)installations. Yoonha, would you like to share your question with the group?

• Yoonha Kim: As a co-curator of this exhibition, I'm interested in understanding more about your approach to making an exhibition as a research endeavor. In collaboration with curator Pauline Doutreluingne, who is known for her insightful curation, this process seems to have a dual nature, combining aesthetics and research. Clemens, your world seems to embody the aesthetics of research, presenting data and creating an aesthetic envelope of what research entails. It raises the question of whether the exhibition as research is an end in itself, focusing on the curatorial form and its composition, or if it serves a larger purpose, such as altering relationships between entities like humans and worms or reshaping our connection with the atmospheric conditions we're currently experiencing in this space. What does the concept of exhibition as research mean to both of you, and how does it extend beyond the curatorial realm to impact various relationships and dynamics within the showcased elements?

• ADHJ While curator Pauline Doutreluingne is not present here, you acknowledge her unique approach, delving deep into research and uncovering unconventional spaces that are artistically enriching. The work forms a cohesive whole in my practice, not compartmentalized into discrete projects like *The Worm, Into the Wild,* or other endeavors. The interconnectedness is significant. For instance, *Into the Wild* preceded *The Worm,* where I created an edible landscape, exploring ecology, plant history, colonization, and the essential roles of bacteria and worms in plant growth. This venture naturally led me to explore worms more profoundly. Prior to *The Worm,* I delved into *Ziggy and the starfish* (2016–2022), investigating sea sexuality. This exploration uncovered the intriguing abilities of flatworms, such as changing sex and engaging in unique mating dances. The fascination with these remarkable phenomena prompted further questions, such as the transformation of soil into solid material. This journey demonstrates how my work evolves organically, following the questions that arise, connecting diverse topics, and contributing to a continuous exploration of the unknown.

• BW The way Pauline Doutreluingne approaches exhibition topics resonates with my process. Sometimes, you start with a predefined theme or artistic position, and then the journey begins. Or you source content and end up doing it the other way around. One way or the other, each approach is rooted in ongoing research. In conversations with artists and researchers, I envision how the information could be displayed, contemplating various forms of presentation across different spaces, physical or digital. It's a dynamic and interconnected approach that extends to forming assumptions, connections, and collaborations in the broader context of exhibitions. Many thanks for sharing your knowledge and your insightful contributions to the discussion!

STRETCHING SENSES SCHOOL

Maxime Le Calvé and
Yoonha Kim

Intermezzo 5

The *stretching senses school* was an education-as-research project at Tieranatomisches Theater (TA T) in the context of the exhibition *Stretching Materialities*, co-partnered with the Node Institute Berlin. Through a workshop-based contribution to the exhibition, we have engaged in collaborations with digital artists and creative coders in order to raise the public's awareness of the multiscalar and embedded interconnections between humans and other earthly beings. These connections unfold through electromagnetic currents, drifting clouds, and the traces of time beyond human perception etched in limestone and soil. In Virtual Reality (VR), visitors interacted with these dynamic processes that are invisible to the naked eye. We started from a relatively simple statement that engaged with the exhibition's thematic while opening to bigger ecological issues: the severity of the climate crisis is well recognized, yet the slow and prolonged nature of these changes often escapes our immediate perception. Can stretching senses help to better understand the presence of non-human entities, and could such heightened awareness lead to a shift in a human-centered relationship? Playful approaches beyond the realm of rigid academic ways of knowing—such as heavily theoretical and often text-based forms of analysis that prioritize rationality, objectivity, and standardized methods—may offer an alternative pathway. In this brief ethnographic, almost telegraphic report, we present an account of the activities that we have curated part of the *stretching senses school* collective. The collaboration of digital artists, creative coders, and researchers was structured into three distinct groups: *Antennas*, *Leaking Bodies*, and *Subterranean Matters*. Each group's work culminated in a final festival that showcased high-quality immersive artworks, documented in the radical open access publication »*stretching senses school*.« In the following log book, we narrate the experimental framing we established for the members of these three teams. Amidst the urgent political, social, and radical responses to climate change, this seemingly light-hearted approach may be seen as insufficient by critics who argue for more direct actions. While political action is crucial in addressing climate change, our approach complemented it by cultivating awareness and reorienting perceptions. In this context, awakening sensory awareness through alternative approaches became essential. This approach explored how perception can be stretched beyond the immediate and the visible through making and experiencing VR: listening to magnetic waves, sensing the world through antennas like insects, or studying the slow formation of limestone. → Stretching Time, 224 These transformations occur not only in ecological consciousness but also in recognizing the porosity between art and anthropology, between digital production processes and scenographic experiments. In the documentation, readers can browse through the varied inquiries that designers/producers need to conduct in order to address the imperatives (and possible trade-offs) of the human perception of the visitors and the contingencies of the time-pressured bricolage of nifty art science projects that were partly developed independently and outside the *Stretching Materialities* exhibition.

Digital devices and their multisensory experiences, like VR, offer new ways to sense and coexist with non-human entities. For instance, one may learn more about trees in the rainforest and empathize with them through turning one's arms into tree branches in VR like in Xin Liu's collaborative project, *Tree* (2017). However, these technologies, designed within human-centric frameworks, carry embedded assumptions and biases that reflect existing power dynamics. Their use is often restricted to privileged groups with access to such tools, reinforcing inequalities and limiting broader participation. Moreover, while they stretch our sensory faculties, these technologies simplify non-human experiences to fit human understanding, failing to capture their full complexity. Despite these challenges, the *stretching senses school* aimed to explore still new ways of engaging with immersive approaches, believing these experiences can inspire new forms of awareness and help reimagine our coexistence with other-than-human beings in the more-than-human world. As Anna Tsing (2015, 37) reminds us, anthropomorphism can be useful if it helps foster environmental care.

Fig. 1: Warja Rybakova in VR experience of the project *Subterranean Matters*

A portal-like VR elevator was built into the center of the round exhibition space. Visitors could hitch rides across temporal and spatial scales with it. Early on, we envisioned this device as a platform for collaboration. Through the *stretching senses school*, we were sharing and extending this toy with other artists, programmers, and digital activists who were interested in stretching senses and blending the physical and virtual in hybrid setups—producing compelling experiences, which help to challenge our anthropo-centered imaginations and acknowledge our hypo-subjectivities in the face of the climate crisis (fig. 1). We wish to keep attending to this community of »members,« who, we hope, will pursue their activities in the years to come, fostering playful and excessive collaborations between ecological humanities, creative coders, and digital artists. With the intention to build participation of the Berlin-based artist community, we have designed a process in collaboration with the Node Institute and mentors in order to balance and »contain« the project in a manageable working process.

Fig. 2: Preparation of the *stretching senses school* festival

In 2021, we received around thirty applications in response to our call directed primarily at visual creators, 3D artists, programmers, and sound designers based in Berlin. The participants were all young professionals. Some were teaching in art schools, some were undertaking graduate studies, and all of them were working as freelancers. Among them were freelancers working for some of the finest digital studios in the city. We selected a balanced group, using the criteria inclusivity, variety of skills, levels of experience, and working contexts. Not surprisingly for the Berlin scene, we counted 14 different nationalities in a group of 15, curators included. The members of the school received modest financial compensation for their time and accepted to take part in the activities and complete the production of artworks. The school's design mentors shared their

Fig. 3–4: Workshop »Leaking Bodies« during the *stretching senses school* Festival, 2022

experience and engaged on equal footing with the school members to produce research and design works in collaboration with Object Space Agency (OSA) within the Cluster of *Excellence Matters of Activity* (MoA). They were offered to exhibit their results and collaborate on interdisciplinary research publications. We communicated a set of instructions in the call for participation. Re-reading these instructions after the collaborative work, it is surprising how accurately we already formulated our demands to the participants: »Use immersive technologies to challenge our commonsensical/modern perception of materials (stones/air/silk) and non-human/more-than-human beings (neuron cells/rattan plants/air-borne bacteria) and their intrinsic activity. Visualize/sonify/evoke interaction with more-than-human beings at radically other scales, turning perceptive information from scientific instruments at the levels of nano/micro/macro/cosmo into sensorial (and therefore interactive) experiences. Visualize/sonify borderline, equivocal boundaries (between the virtual neuron cell and the probe/rattan surface and the moisture of the room) exploring its virtual/temporal/spatial dimensions in alternative sensorial/synesthetic manners.« Yet, the willingness of the group to follow the programmatic lines that we had traced in advance, aligning with the concept of the exhibition *Stretching Materialities*, has shown to be quite extraordinary (fig. 2–4).

A FIELD LOG

PRELIMINARY EXPERIMENT: Fermentation as Attunement

- Date: September 2021
- Objective: Establish initial group cohesion through a non-verbal, embodied practice that resonates with more-than-human agency. Rather than discussing »more-than-human agency« in abstract terms, we will explore what it actually means through direct, hands-on engagement.
- Method: Participants engage in a collective fermentation workshop, a practice tied to the ongoing research of the Ferment-Activity Club at MoA. The slow transformation of food serves as a metaphorical and material grounding for the upcoming VR-based explorations.
- Observations: The shared act of chopping, pressing, and sealing vegetables generated an unexpected sense of intimacy, fostering non-discursive communication within the group. The microbial transformations underway in the fermentation jars mirrored our own transitions from individual practitioners to a collective research unit. Along the way, the unexpected eruption of microbial life—when an entire jar of peppers burst into bloom with mold—presented a reminder that material agency unfolds beyond human intention.
- Outcome: The lunch activated a trans-scalar awareness of food as an ecological assemblage, reinforcing the research premise that immersive experiences extend beyond digitality.

EXPERIMENT 1: Sensory Calibration and Spatial Immersion

- Date: 14 October 2021 (Kick-off Workshop)
- Location: Tieranatomisches Theater (TA T), Berlin
- Objective: Develop an embodied sensitivity to material entanglements through guided meditation and scenographic exploration
- Method: Initial meditation focused on bodily interdependencies with the environment, followed by an exhibition tour emphasizing the research processes of OSA.
- Observations: Participants demonstrated heightened perceptual awareness, engaging deeply with the materiality of the exhibition space. The weight of stone surfaces, the movement of air, and the presence of unseen forces became tangible through somatic attention. This exercise validated our hypothesis that an aesthetic mode of engagement can serve as an epistemic bridge between anthropology and digital art.

Secondary Procedure: Experimental Lunch

- Date: 14 October 2021
- Location: Tieranatomisches Theater (TA T), Berlin
- Facilitator: Akko (Roku Berlin)
- Objective: Explore human—non-human food relations through a performative meal using the ferments of the first workshop

EXPERIMENT 2: Photogrammetry as a Sensory Prosthesis

- Date: 15 October 2021
- Facilitator: Mickey van Olst
- Objective: Introduce participants to photogrammetry as a method for transposing physical objects into malleable digital forms
- Method: Workshop participants used photogrammetry techniques to capture objects, transforming them into interactive 3D environments.
- Observations: The exercise reinforced the research question: Can immersive technologies challenge human-centric perception? Photogrammetry enabled an estrangement from habitual ways of seeing, turning objects into fluid digital entities. The analogy presented by van Olst—»climbing a fence to a special place at night with your camera«—resonated with our broader inquiry into sensory extension.

EXPERIMENT 3: Narrative Architectures of Immersion

- Date: 15 October 2021
- Facilitators: Jemma Woolmore, Nayeli Vega
- Objective: Examine the role of storytelling in constructing immersive experiences
- Method: Participants analyzed literary and cinematic examples before generating their own micro-narratives around stones.

- Observations: Narrative structuring proved fundamental to creating immersion. Participants' engagement with stones as narrative objects expanded the concept of storytelling beyond human actors, aligning with the project's interest in non-human agency.

EXPERIMENT 4: Digital Toolkits and Collective Composition

- Date: 16 October 2021
- Facilitator: VanTa
- Objective: Equip participants with technical skills for VR-based artistic research and establish our endeavor into the notion of digital materiality
- Method: Overview of state-of-the-art creative coding tools, followed by team formation via online collaborative mind mapping
- Observations: VanTa introduced not only creative coding tools but also explained what happens inside computers when making VR—how the CPU (Central Processing Unit) acts like the brain, coordinating different things at once, and the GPU (Graphic Processing Unit) works like a muscle, handling images and animations. This made visible the physical work behind digital images, from electricity use to the materials inside the hardware itself. This awareness of digital materiality added a new layer to the participants' understanding of what it means to create immersive environments. The digital platforms themselves quickly became evolving archives of research-in-progress. This was essential because the VR works were sensory and nonverbal, defying conventional documentation. To capture both process and ideas, participantsplaced images next to texts, scaled visuals, and drew connecting lines—creating a web of relationships. This process not only documented the work but also shaped the creative flow itself, constantly balancing artistic freedom with technical limits.

Interim Review: Progress Check-Ins

- Dates: 16 November, 5 December 2021
- Objective: Assess the development of research and creative processes through structured feedback sessions
- Method: Two scheduled review sessions in which teams presented their progress to mentors, curators, and MoA members (Clemens Winkler, Natalija Miodragović, Nina Samuel, Habakuk Israel, and Robert Stock). Discussions focused on conceptual clarity, technical feasibility, and multimodal storytelling approaches.
- Observations: The iterative review process facilitated an emergent form of collaborative ethnography, in which digital tools such as Miro boards became integral not only for coordination but also as evolving repositories of shared knowledge. These platforms served as living archives, capturing the flux of creative decision-making and reinforcing the dialogic nature of our research framework. The sessions also highlighted the necessity of balancing experimental freedom with structured milestones in order to maintain coherence across the different artistic research trajectories.

FINAL PRESENTATIONS AND EMERGING HYPOTHESES

- Date: 16 December 2021
- Objective: Assess the artistic research outputs and their alignment with the initial conceptual framework
- Method: Hybrid presentations combining in-person and online formats
- Observations: The exhibited works demonstrated a convergence between the project's theoretical aims and the experimental outputs. The use of immersive technologies successfully challenged human perception of materials and non-human agencies, albeit with persistent epistemic constraints imposed by technological mediation. → Stretching Senses, 124–125

stretching senses school Festival: Full-Scale Deployment

- Date: 23–25 June 2022
- Objective: Expand the research findings into a public-facing event integrating VR, performance, and theoretical discourse
- Method: Site-specific VR installations, lectures by digital and environmental scholars (Dominic Boyer, Lisa Messeri, Tim Morton, John Tresch), opening performance, and participatory workshops by the three sub-projects teams, who shared with the public key elements of their explorative process (fig. 5)
- Observations: The festival emerged as a lived expression of our experimental framework. Notable contributions included:
  — *Willowalks*: A sound exploration workshop using willow branches to translate vibrational frequencies into auditory experience (Lee et al. 2022) → Stretching Senses, 271 → Intermezzo 3, 194
  — *Leaking Bodies*: An engagement with the permeability of material forms (Roschka et al. 2022) → Stretching Senses, 273
  — *Subterranean Matters*: A tactile investigation into geological processes (Pekcagliyan et al. 2022, fig. 6)

The event validated our initial premise that sensory extension can destabilize anthropocentric perception, fostering new modes of ecological relationality. ❑ Process, 278–279

REFLEXIVE ANALYSIS: Non-Doing and the Trickster Anthropologist

Throughout this process, a counter-intuitive insight emerged: the most generative moments arose not from structured methodologies but from pauses, hesitations, and acts of non-doing. The fermentation workshop, the mindful attunement to the exhibition space, and the performative lunch—all instances of slowing down—proved foundational in recalibrating perception. Presence, rather than intervention, becomes the mode of engagement.

It echoes Ingold's (2011) argument that »knowing from the inside« is cultivated through sustained attention rather than instrumental control, a perspective that challenges traditional ethnographic fieldwork models predicated on extractive observation and structured analysis.

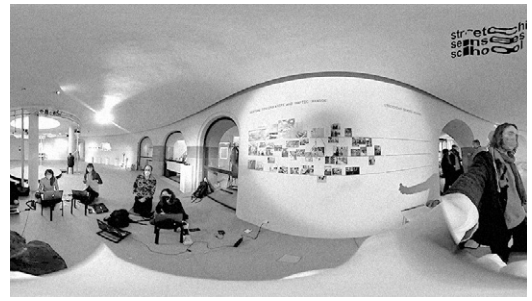

Fig. 5: 360° camera view of the *stretching senses school* festival

The anthropologist in this context operates as a trickster figure, unsettling conventional epistemic boundaries. Trickster methodologies, as developed in anthropological theory, suggest that knowledge is not

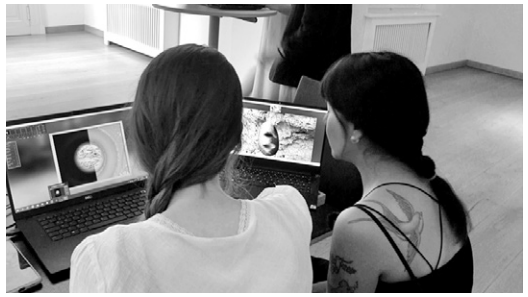

Fig. 6: Workshop *Subterranean Matters*

only transmitted through linear discourse but also emerges through disorientation, failure, and play (Wagner 2010; Law 2004). Rather than merely documenting or facilitating, we played with the elasticity of the research framework itself, actively intervening in the porous zones between disciplines. The *stretching senses school*, by its very name, became an exercise in boundary-pushing: between art and anthropology, digital and physical, cognition and sensation. In line with de Certeau's (1984) everyday tactics, our approach privileged the improvisational and the contingent as valid epistemic modes. In the end, it was not only senses that were stretched but also the ways we imagine knowledge production—a reminder that anthropology is at its most productive when it resists closure and instead embraces generative uncertainty. The project continues; rather than presenting a finished conclusion, it offers an invitation to dwell within these tensions, to keep stretching, and to embrace the possibility of an anthropology that moves beyond the seen and the said into the embodied and the enacted.

References

de Certeau, Michel. 1984. *The Practice of Everday Life*. University of California Press.

Ingold, Tim. 2011. *Being Alive: Essays on Movement, Knowledge and Description*. Routledge.

Law, John. 2004. *After Method Mess in Social Science Research*. Routledge.

Lee, Chloé, Samuel Perea-Díaz, and VanTa. 2022. Antennae. A performative sound installation featuring the willowphone. *stretching senses school*. Matters of Activity. https://doi.org/10.21428/7c901fb3.48b430dc.

Pekcagliyan, Baris, Warja Rybakova, Najeli Vega, and Paulina Greta. 2022. Subterranean Matters. *stretching senses school*. Matters of Activity. https://doi.org/10.21428/7c901fb3.6fd60eb4.

Roschka, Charlotte, Hugo Larqué, Karolina Żyniewicz, Jemma Woolmore, and Mickey van Olst. 2022. Leaking Bodies. *stretching senses school*. Matters of Activity. https://doi.org/10.21428/7c901fb3.cf0b230f.

Tsing, Anna Lowenhaupt. 2015. *The Mushroom at the End of the World — On the Possibility of Life in Capitalist Ruins*. Princeton University Press.

Wagner, Roy. 2010. *Coyote Anthropology*. University of Nebraska Press.

FROM PERFORMATIVE MEDIATION TO DANCING CACO3

Claudia Blümle in conversation with Kaaren Beckhof

Intermezzo 5

• Claudia Blümle: After the opening of *Stretching Materialities*, the research group Object Space Agency (OSA) quickly realized that, due to the exhibition's processual and interactive character, various forms of on-site mediation were necessary. Kaaren, you were the conceptual director for this task. Not only do you have many years of experience in museum education, but you are also artistically active in the field of performance art. Experiencing your guided tours, which I attended and accompanied several times, I found it interesting that there was no linear narrative, analog to our exhibition. As the exhibition changed over several months, your starting points and references for mediation were also constantly in flux. In particular, I remember you made the role of humidity a topological pivot. For example, humidity and water are important for Natalija Miodragović to be able to soften the willows and stabilize them again, and this humidity was in turn perceptible in Clemens Winkler's cloud. You also emphasized the humidity, temperatures, and airiness when you wore Yoonha Kim's *hanbok* clothes during your tours.

• Kaaren Beckhof: The hygrometer also works via humidity, which expands the length of the horsehair used.

• CB Yes, exactly. In other words, there were connections that ranged from the temporal, spatial, and physical to the ecological level. What connections do you remember coming up in the exhibition constellation? As a bridge between the different positions that were exhibited and could be experienced?

• KB In addition to humidity and temperature, aspects of perception generally run through the exhibition as a cross-cutting theme: the described perception of time but also the perception of movement, sound, weight, (surface) structures and patterns, proportions. We are offered the opportunity to become aware of our everyday perspective and to expand it or leave it altogether. Let's take the proportions: Natalija's willow structures, for example, take up patterns for architecture with which we are familiar from handicrafts in small formats. It is surprising when these are suddenly enlarged many times and reproduced with willow branches. What happens when we transfer the shapes of our clothing, which protects and warms us, to architecture? You could crawl through the tunnel in the archway. ❑ Exhibition, fig. 11, 133

This created sounds, the structure expanded and contracted with your own movement, a new experience. The size corresponded with a nest for us, larger, more stubborn than textiles, less comfortable, and not as nice and warm but more reactive, more flexible than buildings as we know them here. In southern China, there are renewable, self-regenerating bridges that have been maintained for over 150 years and have withstood every earthquake. With the cloud in the rotunda, »enveloping atmospheres,« Clemens makes perceptible the materiality and activities of the air, which we often refer to as »emptiness.« First, there is the cloud that forms every twenty minutes, moves gracefully, and dissolves again. But it also collects organic and inorganic particles with an air collection filter. These are made visible and described scientifically with images from scanning electron microscopes, as well as becoming more actively perceptible through role-playing games with names and stories. Nina Samuel's geological collection was later expanded at the suggestion of a visitor. The scanning electron micrographs of weathering processes of stones taken by the visitor's father, the founder of building material microscopy, show the ambivalent zones between inorganic and organic materiality. → Stretching Time, 247–252

The general aim of the exhibition was to discover materials' hidden activities, and it was initially important for you and then for us in the mediation to activate the visitors' perceptual abilities and, to some extent, their ability to move. For us, however, it was first and foremost important to convey that the exhibition was active, namely processual: an interactive laboratory of transdisciplinary research made accessible to the public. In a city with over 250 museums and a multitude of exhibitions, this meant redirecting expectations when visiting the exhibition. The exhibition as such was never »finished« in the sense that it was completed at the vernissage or at the finissage, because we tested the exhibition as a scientific method. It continued to develop in a lively way during the day-to-day research and exhibition activities. Open communication and offers on many levels of participation testified to the honest and determined processual nature of the exhibition. I have already mentioned the importance of personal mediation for the especially innovative VR format. The constantly changing exhibition reality showed that intensive personal mediation was indispensable for the functioning and success of such an exhibition project. It was also important to be quick and to make decisions according to the situation for conventional media communication channels to be able to keep up. Personal mediation was therefore needed to accompany the research process, but above all, to uncover it in the first place! It ensured liveliness and helped the audience to feel comfortable and safe. The exhibition demanded a high degree of personal initiative and responsibility. The doors of the showcases were mostly open. Many exhibits were intended to be touched and used. Others, however, such as electronic devices, were not. Visitors often didn't know how sensitive the individual items were. The bottom line was that a healthy balance of courage and caution had to be actively found when handling the objects. This was sometimes taught through instruction but more often through our example and cooperation. Free trial and error was difficult here as the primary method. Well-practiced conventions of not touching exhibits, for example, hindered visitors just as much as the lack of limits to handle objects completely freely with the risk of destruction.

• CB As it was a transforming and developing exhibition, interdisciplinary exchange with all participants was necessary throughout. How was this realized?

• KB There were extensive communication channels and constant exchanges between the research and education teams. Here too, the »rules of the game« were negotiated and newly developed. This was supported by an online protocol in which we exchanged information with each other on a daily basis. The ultimate success of *Stretching Materialities* as an exhibition was due to the fact that the audience was constantly expanding to include new target groups, primarily through word of mouth. The results of many workshops and other events were integrated, as were the artistic works by myself and my mediation colleague Maria Mascha Kobylenko. This integration made the mediation work stimulating and powerful. There were not only dialogue- and action-oriented guided tours and other planned mediation offers but also situational ones at all opening times. Interested visitors were addressed and initially referred to the exhibits and topics they were interested in or about which they had questions, or they were simply offered a guided tour for the time they brought with them. We built bridges everywhere. In summary, I identified four cross-cutting themes for myself: 1. perspective sense, 2. perspective virtual, 3. perspective activity and 4. perspective stage. The theme of perspective sense posits that perceiving materialities as active and powerful requires all the

senses and that leaving the human perspective stimulates an altered perception of the familiar. The perspective virtual theme was close to Christian Stein and his VR team from gamelab.berlin. They collaborated with all the research groups involved in the design of the individual floors. From the virtual dimension, it was possible to transition between research projects. The hidden activities of matter were actively discovered by visitors in an acting research exhibition laboratory. The fourth cross-cutting theme addresses the spatial aspect, which has always been central to my art. I derive it from my ideal-typical guided tour, which presents all seven exhibition projects one after the other. I initially called the cross-cutting theme perspective habitat because it was about localization (as a human being). Later, in reference to the location of the exhibition, TA T, it became a perspective stage. From here, the references to stretching emerged in relation to stretching time, or the temporal dimension of matter, such as stones, or in the historical sense and a time beyond human. Or stretching size and changing dimensions, stretching and extending the body, stretching spaces, stretching the environment, stretching reality in the sense of analog virtuality. I understand virtuality here in the artistic sense, i.e., something that goes beyond the self-evident, that has experienced a special setting, has been »made special,« as anthropologist Ellen Dissanayake (1988) would put it.

• CB The finissage was just as important as the vernissage, which is why I would like to continue our conversation with your performance *dancing CaCO3*. Would you like to start by briefly explaining the initial situation and concept?

• KB When I got to know your exhibition project, I immediately recognized clear links to my artistic work with a South Indian scattered drawing technique (fig. 1). After more than four months of exploration and mediation in *Stretching Materialities,* my performance literally wove itself through the exhibition, from the general impulse of research to the most important cross-cutting themes formulated for my mediation in the exhibition, to references to all the research projects involved. *Stretching Materialities* was about making matter an active and powerful experience. My performance title *dancing CaCO3*, read »dancing calcium carbonate,« ties in with this. On the one hand, it describes my relationship to my most important artistic material for years, marble powder. This consists almost exclusively of calcium carbonate, (carbonic acid) lime. I use it to scatter temporary drawings on the ground while standing in a forward fold. As soon as a drawing is finished, it begins to disappear, just like life itself. Beyond traditional genre boundaries, I create local-spatial situations that evoke specific aesthetic experiences. By »dancing« the chemical formula of calcium carbonate in the title, I emphasize the intrinsic activity of my drawing material—independent of my actions as a draughtswoman. On the other hand, by »dancing CaCO3« I refer to the performance, which I conceived as an open, participatory choreography. Alongside me, the audience follows the staged impulses of the material as »dancing« performers. They »dance calcium carbonate« by engaging in exploring its activity in the exemplarily presented manifestations with all their senses. The ceremonial performance was staged at the finissage of *Stretching Materialities* in three runs of 45 minutes each at one and a half hour intervals. Each run was divided into two parts of roughly equal length. In the first part, I introduced the audience to the »ceremonial performance« in terms of concept, content, and practice; in the second part, it was performed in a ceremonially focused manner.

Fig. 1: *dancing CaCO3*: Kaaren Beckhof drawing a stylized coccolith from million years old coccoliths using calcium carbonate in its manifestation as ground marble

• CB It was a performance that could be received passively but also invited active participation. Would you like to describe this relationship between passive and participative performance on the sensory-perceptual side?

• KB I had developed five stations for the exhibition to stimulate the audience's curiosity about the sensory exploration of CaCO3: *Shell Song, Shadow Drawings, Osmotic Fingers, Flavors of Marble,* and *Bending Organ*. Picture the second part: The light dims as the audience, now the performers, move into the rotunda space with me. At first, delicate sounds can be heard, which they produce themselves using shells. Extremely focused on these soft, grippy sea almonds, real hand candies that I collected on the Atlantic, they devotedly explore their sound possibilities. Some press them firmly to their ears to listen to their inner sounds, the familiar »sound of the sea« (fig. 2–3). They linger or meander through the circular space with attentive senses. The acoustic signals are picked up by the sound artist and composer Wingel Mendoza. For *Shell Song,* he performs on a floor cloth with objects that are also part of the exhibition. He uses microphones at different locations to record and incorporate the incoming sounds live into his improvisation. This creates a unique spatial sound fabric in direct resonance with the performative events. It is unobtrusive and has the effect of the clicking and crunching of subterranean rock strata, the sound of the sea, or the noise in space, a living, three-dimensional sound environment.

Fig. 2: *Shell Song*, station of *dancing CaCO3* is inspired by the sounds of calcium carbonate in its manifestation as sea almonds. Electronic live composition by sound artist Wingel Mendoza

Fig. 3: Audience performs while listening to, exploring, and creating the sounds of sea almonds in a ceremonially focused manner

The metal bowls I use as containers for the marble powder resound like bells, solemnly. Meanwhile, leaning forward, I myself continue to scatter a larger floor drawing that I started earlier and which winds its way around the rotunda. The graphic patterns are based on wavy lines and loops, picking up on the labyrinthine patterns I usually use, as well as related patterns that are

present and significant in the exhibition. Many performers place their shells in self-selected locations, others pick them up again or move on to other activities. They follow their individual rhythms, choose their own sequences, decide what to do according to the situation, while maintaining their concentration on the calcium carbonate present and their open, undirected perception of the space. In short, the shells refer to the oceanic background of the marble. Together with the exoskeletons of crustaceans and protozoa such as coccoliths, they were deposited in primeval seas. They became limestone, i.e., sedimentary rocks like chalk. Under the special effects of pressure and heat, a metamorphic rock, marble, was formed in some places.

Fig. 4: *Osmotic Fingers*, station of *dancing CaCO3*, uses a paste made of calcium carbonate in its manifestation as chalk and water

Fig. 5: Inspired by the ever pointing fingers spotted during the exhibition, particularly when using VR and the *Virtual Sensing Knife*

I then led everyone back into the rotunda and gathered them together. For *Osmotic Fingers* (fig. 4–5) I placed calcium carbonate in the archway to be used as a paste—Rügen chalk powder mixed with water in a bowl—so that performers could spread the mushy chalk on their index fingers. The evaporative cold is clearly noticeable and accompanies the first movements of the now white-marked fingers. They are an echo of the many isolated index fingers in the exhibition, like the tip of the *Virtual Sensing Knife* or the »blind« visitors with VR glasses when they select the floor in a Virtual Elevator. Later, the fingers trace wavy lines of my scatter drawing, point to or into a cloud that is actually floating above them in the rotunda, they notice its humidity, its undulations, and much more. The index fingers, emphasized in isolation, remain a striking aspect of the performers. Meanwhile, they are inevitably permeated by the ingredients of the Rügen healing chalk used here. Some fingers point to the gigantic enlargement of a coccolith that I have scattered, from which the chalk was once formed. In the end, the crumbling of the dried chalk leads to new sensations and movements in the room—and to particles that are continuously collected, measured, and determined in the exhibition.

• CB In addition to these sensory experiments and spatial measurements of the body, the senses of taste were also involved, weren't they?

• KB Yes, with *Flavors of Marble*. That was a station where you could taste calcium carbonate in the form of my marble powder. Nobody expects a taste explosion here. But something surprisingly different is revealed: the haptic sensitivity of our mouths when eating. The marble particles have the ability to move around freely in the atmosphere of our mouth, to »dance,« if you like. When ingested as a powder, they are initially very dry and love our saliva, which mobilizes them. They become difficult to control, and our movements initially spread them further into the oral cavity. It takes quite a while for them all to disappear (fig. 6–7).

Fig. 6: *Flavors of Marble*, station of *dancing CaCO3*, introduces the tasting experience into *Stretching Materialities*

Fig. 7: Particles will dance around in the atmosphere of the mouth

• CB How did your performance with the active materials in our *Stretching Materialities* exhibition become a dance?

• KB The cloud's humidity relates to the wet, white fingers, chalk and marble to the exhibited stones; powdered and drawn with, these limestones transform into the bows of the willows, the latter followed by the pointing fingers typical for the Virtual Elevator, the cautious movements of the VR experience transform into the ceremonial style. Performers meander; white, osmotic fingers explore, swinging lines, clicking shells; attentive, exploratory gazes; movements carried by sound like strange-looking forward folds (fig. 8). The *Bending Organ* is where gravity comes into play, the exploration of the weight of the marble flour. ❑ Process, fig. 1, 265

Fig. 8: *Bending Organ* as part of *dancing CaCO3*. Audience-performers follow the impulse of marble powder's weight

Placed on the floor of the rotunda, there are white belts with weighted bags that I designed in relation to the Korean robes (*hanbok*) in the exhibition. Performers tie them carefully around their waists. Where the stiff collar of the *hanbok* stimulates an upright posture at a point on the neck (more on this later), here the weight of the marble flour on the kidney area stimulates the correct, relaxed forward fold. The performers bend forward alone, in pairs, or in groups. Now and again, individual performers also pause. They follow the solemn, whimsical goings-on for a while as if in a strange, mysterious world: people, absorbed in their forward fold, others who slowly, very slowly bend forward and then straighten up again, others who seem to mirror my forward fold or comment on it. What are they bowing to? A very slow, graceful up and down. Rhythms emerge. People moving carefully, trying to trace their connection with something unknowable, with something that surrounds them, even moves through their bodies. With calcium carbonate, one of the most widespread compounds on Earth. With its sounds. At every moment, however, their own position, their own perception is unique.

A celebration of the here and now evolves. The door opens. The next audience enters and watches from the sidelines for the last five to ten minutes. They witness the ceremonial performance, a »dance,« as the others allow themselves to be moved through the room in an astonishing way by something still undefined for them. I think that this has created its own atmosphere and a new aesthetic in this space that was not previously present in this exhibition.

• CB Yes, that's how I remember it too. Especially the fact that not only the light but also the different placement of objects in the room and the emphasis on the floor with the drawings made of marble flour created different weightings and constellations that once again changed the topological relationship structure of the exhibition. With regard to the exhibition as a whole, I would like to ask you about the different stages and the paths of the various stations in the exhibition. The first thing I would like to pick up on is Natalija's willow structure. The interwoven lines resulting from the weaving were recognizable in your drawings on the floor. These were direct paths that emerged between you. Sometimes one had the impression that the shadows of Natalija's willow cult traces merged seamlessly with your drawings. Would you like to say something about these references?

• KB I immediately felt connected to Natalija's large willow shapes. They are based on similar linear curves as some of my labyrinthine patterns. Natalija bent the individual willow branches and then interwove them. To form the high tower structure, she needed lots of individual willow branches, which only grow to a certain length. I interweave similar line elements two-dimensionally to form complex patterns by arranging them on top of one another, limited by how much powder I'm able to hold in my hand. The shadow cast by Natalija's *Willow Tower* inspired me to follow its lines. The willow structure also reflected light, creating a similar network of lines. Then one day we discovered a light reflection of a similar kind near the entrance area. It must have come from outside. But we couldn't be sure where it came from before it disappeared again. I see these line patterns everywhere.

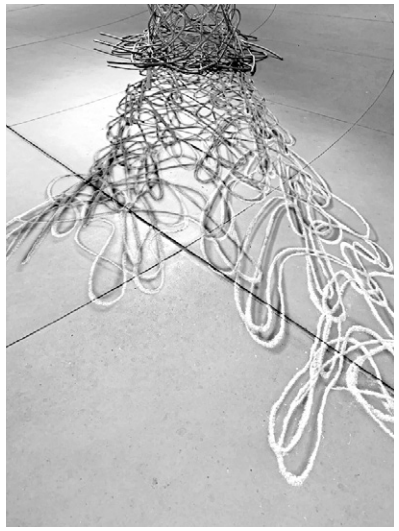

Fig. 9: *Shadow Drawing* as part of *dancing CaCO3*, developed before the finissage and performed repeatedly

• CB So there was both a shadow and a light projection?

• KB Yes, and both are extremely ephemeral phenomena. In contrast, my scattered drawings are made of tangible material, but they are just as ephemeral. Tracing the shadow of the *Willow Tower* was my first scatter drawing in the exhibition space in February 2022 (fig. 9). A few days later, two children curiously asked whether they could touch the drawing. They then began to trace lines, just like me. This time not with stone powder but with an outstretched finger (!) in the stone powder. They followed the sweep of my scattered lines, but at some point they detached themselves from the original—until the mesh became a blurred, white surface (fig. 10). They improvised long, lustfully swinging lines into it, inspired by the previous movements and the lingering shadow of Natalija's willow structure. The shadow now fell on the children's bright »stone flour cloud.« Clemens' floating cloud could be seen in the distance that also formed from ever-changing, oscillating lines of bright water vapor. ❑ Process, fig. 9, 272

Fig. 10: The lines of *Shadow Drawing* transformed into a »cloud« through visitors' interaction

• CB The location of Clemens' cloud was the result of climate investigations of dust, humidity, and temperature in the round exhibition space, which came into co-existence as a divine level mediating between the situated exhibition and Christian Stein's Virtual Elevator. During *dancing CaCO3,* you transformed the rotunda into a stage, from which you performed the movements with a weighted belt around your hips. In addition to these references, touching by hand also played a role. What references did you make to the stones and their haptic contact with Nina's showcases?

• KB I would like to briefly describe a mediation situation with her eight-part touch box. → Stretching Time, 224 At the beginning of my guided tours, I liked to ask a volunteer to put their hand into one of these openings without any indication of what they would find. I had them describe in detail what they felt there, size, exact shape, surface texture, weight, and temperature impressions, color (*sic!*) etc. It was not about guessing the material, naming the unknown but experiencing it in its concrete materiality, feeling it. Later, we could see downstairs what we had felt in the eight boxes: the stages of weathering from large river pebbles to sand and silt to clay. A series of unusual and attractive examples in Nina's display cases shows how rock weathers and is formed again. Shell impressions were visible on a limestone, and its calcium carbonate content could be chemically detected with diluted hydrochloric acid.

• CB Here you also have a photo of individual stones laid out on the wall. ❑ Exhibition, fig. 1, 121 What significance does this have for you?

• KB In a workshop organized by Lara Ladik, these stones were picked up by visitors, examined, and placed in different locations. This inspired me to give my audience performers the shells, which have a similarly handy size, to carry around, put down, and carry around again. The same happens to shells and stones in the open air, they have no legs and yet they move. And they are much more persistent than we are, namely millions of years. I also transferred other movements that appeared in the exhibition into my performance, as previously explained: the index finger. Incidentally, the stones in the picture are on the red sandstone wall, the first passageway to the rotunda.

• CB The materiality of stone is often forgotten when it is used and transformed

for objects or architecture, in other words, when you work with stones and use them. At that moment, the materiality recedes into the background again and that is the hidden aspect that I referred to by *Hidden Activities*—our subtitle for the exhibition. The materiality as such is made visible and brought to the fore again. Can you elaborate on the materiality of the stones and their different ways of being?

• KB Three different types of stone come together here. The weathering stages of the river pebbles that we saw before are part of a cycle without any necessary human influence. The sandstone wall in the picture is worked stone, which in turn has its own history as sandstone. And below we have tiles. Stone, but put together, shaped, glazed, and fired by man. An ancient cultural technique! CaCO3 lent its name to a geological age (the Cretaceous period), and now we're living in a geological age named after man, the Anthropocene. Nina's exhibits also included a 3D print of a sand rose. These attractive stone shapes can form under very specific weather conditions, usually in desert regions. The print surprised not only by its enormous lightness, comparable to a pumice stone next door, but also by the fact that on closer examination it has only the size and only very roughly the shape in common with the original, which was also on display, but not the surface structure, which clearly showed the individual plastic layers of the printing process. The printed object feels completely different, its weight, temperature, and smell are different, it behaves differently, falls, tumbles, and tastes differently and does not only reveal its otherness when it is sanded or cut up.

• CB In what way were you able to performatively integrate materials such as stone?

• KB Nina's showcase, which you could reach into, was about the cycle of rocks, how igneous, metamorphic, and sedimentary rocks are constantly transformed into one another through geodynamic processes such as erosion, rock metamorphosis, or sedimentation, and, of course, human influence. The transformability of the material had to be discovered again and again in the exhibition. In doing so, it was central for me to sensitize the perceptive abilities of our body, all our senses. What we have referred to as the sense of touch since Aristotle has been reduced in our text-based i.e. concept-based and increasingly audio-visually dominated culture. When I took lessons from the American dance legend Anna Halprin during my studies in San Francisco in the 1990s, I was astonished to learn that she differentiated the sense of touch into around 36 senses. Without wanting to list them all individually here, or even go into the further processing of sensory impressions in the human body, which is described by sensory and perceptual physiology, we distinguish, for example, surface sensitivity (haptic and tactile) from deep sensitivity (proprioception), we can distinguish between pressure, vibration, touch, stretching, and pain and have cold and heat corpuscles for temperature perception, we also perceive the position of the joints—the sense of position, the tension of the muscles, and vision, the sense of force of their movements—the kinesthetic sense. Visceroception enables us to perceive our internal organs, while the sense of balance in the ear enables us to move in space without getting confused.

• CB Did this also manifest itself at other stations within the *Stretching Materialities* exhibition?

• KB Yoonha's exhibition project ties in well with this. The focus was on the potential of wearing traditional *hanbok*, which literally means »Korean clothes.« → Stretching Senses, 275 They are very valuable, handmade from different silks, and require a special bow tie. I really celebrated dressing in the exhibition. This later inspired the subtitle of *dancing CaCO3—a ceremonial performance*. The ceremonial element also worked well as a ritual to introduce the mediation. One not only visited an exhibition but was also involved as a research object and subject. I introduced the dressing of the *hanbok* comprehensively with perception and posture exercises, such as »Feel where your current clothing rests against your skin. What sensations do your clothes trigger there? Where do you feel particularly soft, hard, delicate, or scratchy skin? Is it warmer somewhere? Colder? Or is there a draught somewhere?« The variety of »tactile senses« enables us to connect with objects in a very differentiated way, including the *hanbok* in this case. When dressed, it is possible to observe how the *hanbok* influences the position of the body in space, sometimes even determining it. Visitors were able to observe how its width and openness and also the fine sound of the fabric invite free, easy movement and promote a straight posture via a stimulus from the stiff collar at the neck. Here we were sensitized to the »agentivity« of the *hanbok*, which manifests itself in interactions, movements, and changes. I tried to stimulate the feeling of the materiality of our own body with *dancing CaCO3,* by offering to taste my drawing material, marble flour, or use it as healing chalk, which penetrates our body during spa treatments. Along with transfer functions, calcium provides strength in our skeleton and teeth.

• CB Now that we have arrived at the aspect of the body, I would like to ask you how the materiality of the body, as self-perception and as perceived by others, analog and virtual, could be experienced in Christian Stein's position?

• KB On the five floors of the VR elevator by Christian Stein and gamelab.berlin, you could walk through landscapes and enter rooms in which all the research projects were presented at the end. For example, you could test the *Virtual Sensing Knife* from Maxime Le Calvé's project. Your own arms were transformed into very sharp, sword-like scalpels with which you could scan, i.e., scan and cut, cells floating in space. You became a virtual surgeon but on a nanoscopic scale. This VR experiment refers to the actual atomically fine tip of atomic force microscopes, for which a single carbon monoxide molecule is used. Here there was even the addition of a sensor-equipped *hanbok* shirt that supported the audio-visual VR experience with vibrations. → Stretching Senses, 305

On another floor within VR, man-sized stones weathered to dust in a matter of seconds when touched.

If you had previously visualized the duration of erosion, including touching river pebbles, in eight stages to clay dust, this extreme time-lapse made you feel, as some visitors remarked, god-like. Or like an even older or more solid stone, bearing witness to the weathering of others, or simply hard-to-imagine-old. I particularly liked using one function. ❑ Exhibition, fig. 18, 138 I let visitors place their hand on the red sandstone wall for a while. When they took it off, a glowing red handprint appeared on the virtual sandstone wall, which they could then watch fade away. This suggested the ability of the sandstone wall to actively communicate its heat sensation, while the human hand had absorbed the coolness of the wall. In many encounters in the exhibition, and especially in the feedback on my performance, visitors expressed a special sense of well-being. This seems remarkable to me, because recognizing activity and effectiveness in the material in an unusual way could also be perceived as a painful

loss of control. Mind you, the audience was very heterogeneous. But can it not also be reassuring and liberating to leave the anthropocentric horizon? I think with Epictetus that this can succeed if we recognize and accept what is not subject to our influence. Metaphorically, I try to draw that.

• CB You basically had a dual role—on the one hand the task of performative mediation and on the other your own artistic performance during the finissage. Normally these are activities that you perform separately. For you, this was the first time that you took on both roles in an exhibition. What was this experience like for you, combining mediating and artistic practices for the first time? Was it also experimental and exploratory for you? And what new impulses did this give you? In both directions?

• KB Above all, the obviousness of the dual role was new for me. The fact that I was officially involved in an exhibition as a mediator and artist for the first time was also made clear in the two-part structure of my performance. In the first part, I led my audience along a classic course (introducing them to their task), in the second part I acted exclusively as a performer/drawer. Just as a change of costume is usually used as a means of illustrating a change of role, I emphasized the connection between my »double role« by wearing a white lab coat throughout, like the one Clemens always wore in the exhibition. As an art mediator, I have always incorporated artistic moments into classical exhibition tours alongside workshops. During my first mediation assignment in 2000 for *Seven Hills* and *Theatrum Naturae et Artis*, the Federal Millennium Exhibition at Martin Gropius Bau, I used seven and eight fresh lemons, respectively. In 2005, for the big *Stanley Kubrik* exhibition in the same building, I boiled a femur calf bone, cleaned, and prepared it. About 40 cm long it was classified as a weapon by the house management. In the end, with support from the very top, I prevailed against all odds and was able to give it to visitors during my guided tour of the exhibition so that I could later use their experiences for a key moment in Kubrick's cinematic oeuvre, one of the most famous match cuts as time jump in film history. An ape throws the cudgel-like bone high into the sky where it seemingly transforms into a similarly shaped spacecraft. It frames the evolution of men from an early use of tools to the travel through space. My interpretations of the respective exhibitions thus took on an artistic form. They were participatory mini-performances based on multi-sensory perception and interaction with the specific materiality of the objects brought along during and in the context of the tour through the exhibition. Over the past two decades, both the influence of mediation on curation and the possibilities for artistic mediation in exhibition venues and museums have changed considerably. However, the possibilities at *Stretching Materialities* as a publicly accessible, interactive, transdisciplinary laboratory were quite unparalleled.

• CB And from an artistic perspective?

• KB As an artist, I have always realized participatory art projects. Examples include *Überall! ist unser Zuhause* with several dozen long-distance truck drivers on the disused AVUS Nordkurve in Berlin or *zwischen Himmel und Erde.* with a village of 1300 souls in Münsterland for my work series *Performative Drawings*. These are designed to last for weeks or months and include mediating activities. Already in my theater days I was interested in invisible »stages« of everyday life, places where something new or unknown subtly emerges. My art studies in California in the 1990s were influenced by what Nicolas Bourriaud later called Relational Art. These were contemporary artistic practices that took human relationships and their social context as their theoretical and practical starting point. In *Stretching Materialities,* we spent months intensively exploring and experimenting with the exhibition, its positions, themes, location, and audience, i.e., with the relationships between active materials in the field of objects, actors, and spatial structures. I found that to be a great privilege. It was above all your research topics that inspired me to create a chemical perspective and new forms, such as *Osmotic Fingers, Shadow Drawings, Bending Organ*, etc., and other works that I did not integrate into *dancing CaCO3*. What was new about my dual role in *Stretching Materialities* was that my artistic and mediating activities apparently oscillated and how strongly they influenced each other. The scientific-creative dimensions, in which you understand matter as active and capable of action, as a dynamic force that unfolds and organizes itself, were enormously inspiring for me. I can't say whether I will continue to develop a performative double role as in *dancing CaCO3*. I would rather merge the roles further.

• CB What role do activity and liveliness play in establishing a connection between your performative work and the movements and stretchings, which in turn were the themes of the exhibition itself?

• KB This is where the oscillation I just mentioned gains central importance for me, because my artistic work has always been based on theories of process philosophy. One of the basic assumptions is that material things are nothing more than a temporally limited, stable order of processes. Important aspects for me are therefore time, movement, change, flow, and emergence as well as transitions and thresholds. Kolams are originally understood to be daily renewed threshold drawings that celebrate the transition between inside and outside, private and public, night and day, the sacred or special and profane, etc. And so *dancing CaCO3* was also about transitions, moving back and forth and through: from the molecular (the abstract chemical formula) to objects that trigger concrete multisensory experiences, from concentrating on the moment to opening up into dimensions of Earth ages, from the strong individual focus of attention (perception with the help of one's own body) to the communal component in space (security, trust), from active doing to surrendering, being guided and allowing oneself to wander through the material, from the laboratory to the ceremony.

• CB As a final question, I would be interested to know whether your participation in our exhibition *Stretching Materialities* has left any traces and whether, in retrospect, there have been any repercussions for your own artistic work.

• KB I had actually taken the enforced corona break as an opportunity to leave my mediation work behind me. However, in addition to the fascinating subject matter, I immediately accepted the request from *Stretching Materialities* precisely because of its conceptual openness. The collaboration in *Stretching Materialities* therefore had no effect on my mediation work for the time being but all the more so on my artistic work: last summer, I pragmatically incorporated the idea of the ceremonial performance into the exhibition *Erdflug,* which I realized in intensive collaboration with the performance artist Klaus Boegel at Wasserturm Geldern. This could be the beginning of a new series of works. The participation in *Stretching Materialities* inspired me to expand my artistic concern of redefining atmospheres with your concern. I wanted to make tangible that non-living objects can have their own »agency,« which manifests itself in interactions, movements,

or changes and how human and non-human entities participate together in the shaping of realities. The reduction of my stone powder to its main chemical component was inspired by the numerous scientific observations of matter in the exhibition. I definitely want to pursue calcium carbonate further but also explore a possible material side of infinity forms. *Stretching Materialities* rekindled a long-held desire to work with mathematicians on the kambi kolam patterns. After all, they can be described mathematically in many different ways, via the Euler path, certain fractals, tiling, Lissajous figures, waves, and symmetries in general.

But finally, and most importantly: the process-oriented concept of an exhibition as a laboratory inspires me to open up my »Kolamschule,« which is activated for participative projects, to a »Kolamlabor.« The »Kolamschule« played a central role, for example, in the above-mentioned works *zwischen Himmel und Erde*. and *Überall! ist unser Zuhause*. I taught performing and drawing skills as well as practical and theoretical philosophical exercises. It was not the artistry or originality of the drawing that was important to me for the final performance but the conscious and reflected devotion of the performers to the materiality of the form, as in *dancing CaCO3*. The performers participated with their context-related identity, here: villagers and truck drivers in their everyday environment in my transcultural intervention. By taking the South Indian form into environments where it was unknown, I changed the parameters of this experiment. There I used documentary means to observe how the atmosphere changed. My studio is actually already a »Kolamlabor.« I experiment here with specifically selected aspects of kolam-making. However, a »kolam lab« could become a place where people are invited to conduct joint experiments, e.g., mathematicians on questions of embodied mathematics... Last summer and before that, I hung upside down and tried my hand at Lissajous figures. I'm interested in how we perceive ourselves simultaneously as matter and as part of the material—and of processes.

• CB Dear Kaaren, thank you very much for taking the time to talk about our exhibition *Stretching Materialities,* your central involvement in the performative mediation, and your artistic performance *dancing CaCO3* in retrospect.

References

Dissanayake, Ellen. 1988. *What is art for?* University of Washington Press.

STRETCHING MATERIALITIES IN BUENOS AIRES

Christian Stein in conversation with Chana Boekle

Intermezzo 5

• Christian Stein: Hello Chana, it's nice that we can reflect on *Stretching Materialities* in Buenos Aires again today. The exhibition came to Buenos Aires in the art museum Sivori after it had already been shown in Berlin, with the idea of adapting it to the new environment and seeing this adaptation as a learning process within exhibition making. What does it mean to transplant such an exhibition, which was made specifically for one space in Berlin, to another place, to another culture with a different audience and a different team? And I would like to hear from you briefly about what you remember, how the project actually began and how this cooperation started over a long distance—also across disciplines.

• Chana Boekle: Yes, at first it wasn't quite clear to us what the idea was and we actually thought that we would host your project and just show it. And then, through our long interdisciplinary discussions, we came up with the idea of involving an artist. Luckily for us, the artist Daniela Castillo Cortez was very enthusiastic about the project and had a lot of ideas, so it developed into something bigger than it was at the beginning. The idea was originally to exhibit the VR headsets and show the different levels of the virtual exhibition as originally shown in the *Stretching Materialities* exhibition in Berlin, yet it then developed into a large installation which included live art, which doesn't happen very often in museums. A lot of things came together that are not normally on display in a museum or an art museum, and certainly not in Buenos Aires. In Argentina, this type of technology is generally not as widespread as it is here in Berlin. One of the ideas behind involving the artists was that they would adapt the project to the institution, because Sivori is already a museum. It actually shows art in a fairly traditional way up to modernism. And *Stretching Materialities* was a pretty good fit to not only show science like art but also relate science to art. As the artist Daniela Castillo Cortez herself had exhibited a work in the exhibition space, the timing was also very good (fig. 1).

Fig. 1: Creating the initial weaving structure in the exhibition space in Buenos Aires

• CS And what do you think was important for this interdisciplinary collaboration to work? It might not have worked with every institution in Buenos Aires.

• CB Exactly, one of the things that was important was mutual trust. First and foremost, it was important for me to have the institution's trust. We started just before the Christmas break and most of the staff were already on vacation. Of course, I had to communicate a lot, but trust was pretty much the key for us being able to continue working. And then trust developed very quickly between the three of us, Christian, Chana, and Daniela. I remained close friends with Daniela, the artist, after the project. We worked together professionally and knew that everyone was working in their own lane and not hindering the other parts and perspectives of the project. So this constant communication was really important. I was more of a producer than a curator, so to speak. The constant contact with you and Dani was central for me to see what could be realized. Dani and I lacked the knowledge of what could be done. We had several meetings to understand what we were actually doing. Somehow our personalities were also a good fit. I think we three actually often like to say »yes« and »we'll try this now« instead of seeing it differently. That's why it was a good fit.

• CS And what impression did you have of the ideas that we then developed together in several discussions, actually mainly the three of us? Did these ideas also come across to the audience, or was it really just an unusual technological experience?

• CB We were actually able to convey a lot to the audience. Of course, the decision to always have someone from the education sector present was also very important. Or, above all, the decision to ensure that visitors can contact someone if they have any questions. So just having this option makes a big difference, I think. That's why this really was a project in which we placed a lot of emphasis on communication. First of all between us in the team, but then also between Daniela, the artist, and Valentina, our colleague from the education department, who was really there to answer the questions.

One of our goals was to show the democratization of knowledge, and it was important that, in order for knowledge to be democratic, you could also ask someone and discuss it. As a result, there was a lot of communication, including questions and comments from the audience. That's what we wanted to achieve with the project, if only because there were several people there to talk to. The idea of democratization was important because it would allow people to approach the topic rather than be frightened. It was important that there were approachable people signaling their willingness to discuss. This also meant that the exhibition couldn't function with its full discursive potential the whole time. So we had times when the artist would work live in the exhibition and could be approached and others, in which the artwork spoke for itself (fig. 2).

Fig. 2: Live Performance of VR and live-weaving of the network by Daniela Castillo Cortez with *Structural Textiles*

• CS Do you have the impression that this live development of the network, which Dani worked on, could also have had a repercussion on her understanding of art or even that of the museum as an institution?

• CB In any case, that became clearer to me when I was working directly with the artist, clearer than when I was working with the institution. A public museum also has different institutional ways of implementing things. Sometimes it's not so easy to break new ground. For us, these were completely new ideas and approaches. Even just the idea that we could combine art and AI so well, for example, was a great and novel experience for us. Many new questions arose for Daniela, and she also incorporated a bit of technology into her artwork. She actually creates textiles, using a very old technique knotting strings together to a spreading network—every string is woven into its particular connection point. She has shown the value of this technique once again. That alone was a great accomplishment for her, as she recognized that her work is also a kind of technology, just different. This realization was very interesting for me to observe. I also liked the way she familiarized herself with other technologies.

• CS There were many parallels, although at first glance you would have thought that the understanding and approaches were very different. We also brought a wicker structure from Berlin to Buenos Aires and combined it with Daniela's thread textures. How did you feel about that? It was actually an attempt to connect structures across very distant places and to bring them into an integrated form.

• CB I have to talk from an aesthetic perspective first because that's more my area, so aesthetically speaking I thought this connection was a clever strategy to alter the museum space by inserting a central object from a different context. Having this structure on site supported the whole installation. I personally found it interesting because I was able to get to know the details of the structure and the artist too. Unfortunately, this part was not so easy for the audience to understand. We had done a lot of research in advance and therefore had a multi-layered insight. A large part of the audience asked themselves questions, as the structure was also mentioned in the text. There were specific questions about its meaning and modes of fabrication, but I don't think the whole scientific background was understood so well, partly because it was really very complex and a completely new experience for most people. And I think that most people first realized that they were dealing with a completely new technology that they don't normally have at their disposal. When we got the structure, we realized in quite a material way that we were working with scientists. And the connection between Buenos Aires and Berlin also became clear through a material object.

• CS Yes, the objects also connected the places. I have more questions about the processual aspect: the exhibition had been developing continuously, all of us carried out the work directly in the exhibition. Were there any questions from the audience? It was an experiment. Did it work? Can you actually start something in the exhibition that is not yet finished and develop it over a longer period of time? How do you think this approach was perceived? Was the process even perceived as participatory or as a performance? Or perhaps even as unfinished (fig. 3)?

• CB What you just described was very important to me and Daniela. The visitors actually had the feeling that they were involved, and that's normally not the case in the art world, which I personally think is a shame, because it really sparks interest when you feel that you're actively participating. That was the first reaction we got from the audience. Sometimes they said it, sometimes they didn't, but that was the basic feeling. Visitors left the exhibition with the feeling that their knowledge, their data, or something they have done has had an impact on the work. And that also changed the audience's relationship with us a lot. You could see that, for example, when people took selfies in the museum. Then, out of curiosity, when we were allowed to, we looked to see what effect these selfies had on us and other commentators when they were posted.

And that was very often »I was there, I've seen this work.« It was interesting for us to know that it really makes a difference for the audience to feel involved in the artistic work. So it's a decision to involve the audience. That was also one of the aims of the project, to overcome the distances between institutions and visitors, to make people feel involved and raise their awareness and interest. There were visitors who came back and recognized the changes in the artist's work.

As a result, the artist Daniela also made other decisions that we hadn't even considered at the beginning. In the beginning, we talked a little about abstraction from an aesthetic and curatorial perspective. Because the audience felt so involved, at some point we made the decision to move from abstraction back to the figurative, because that simply strengthens the relationship between the audience and the artwork. Daniela did a great job and took it to the extreme. Sometimes she even incorporated the faces of the audience into the work.

Fig. 3: The woven structure after a couple of sessions some weeks later

• CS This involvement also changed the artwork and the way of making art. So on the one hand, of course, we had the faces, the impressions, the conversations with the audience, even while Daniela continued to weave the artwork. And on the other hand, we also had an algorithm implemented in the VR app, which translated the audience's movements in VR into instructions for Daniela in an abstract way. For example, if they moved a lot, this translated into a »dense network« instruction for Daniela and the other way around. So it really was a connection that wove the virtual directly into the physical, so to speak. How did you perceive that? Was this a purely metaphorical connection or did it also change Daniela's work?

• CB I think these instructions, this part of the exhibition, had an effect on Daniela in particular, more than on the audience. The project or what they saw in VR was already exciting enough for them. But I think it made sense for Daniela to find an instruction somewhere and get started somehow. Sometimes the freedom is too great otherwise. Yes, and then you're a bit overwhelmed. And for her it was something nice, something good, and something practical to actually be able to start there too. She then also started to pay attention to the audience herself and then perhaps sometimes made different decisions.

• CS Would you say that your perspective on what art is changed as a result after the project for you?

• CB I think the experiences within the project have brought about very big changes, especially to the concept behind artworks. Which is very important. We're noticing that ourselves right now, we're still working together, that our bibliography has changed, for example, or that we have a different idea of how we can incorporate technology, and that we're no longer so afraid or scared of it, now we know that it can be a real enrichment and that we can live together very well. That has already changed a lot. Technology-related art has also changed our professional future, because we didn't choose technology-related projects before. But we've already started working in a more multidisciplinary way than before because the idea of multidisciplinarity has also changed a bit for us. You're a bit in the ghetto in the art world and you assume that as a curator you only work with artists, but since we were also able to show something scientific, it was very important for us to realize that everything has become bigger.

• CS Yes, the discussion should be about a dialog between art, science, and museum in this triangle. And perhaps I'll ask something else about the mutual learning processes: did you have the impression that we as the Berlin team also learned from you and took something away from the artistic and museum sector?

• CB I hope that you have. That's a difficult question that I can't answer very well because I don't know what exactly you had in mind. But I think it was definitely an invitation to include art in scientific projects. As a curator I see that every exhibition is an opportunity to go on stage and show things that raise questions and not necessarily just show answers. And we were pretty much on the same track. For both the scientists and us, it was more important to raise questions than to show answers. And then I think that every exhibition or every presentation is important because it's an exercise in thinking about how we communicate. And sometimes it works very well through art.

I also hope that you have come to this realization from your side. These are different strategies, visual strategies, which also have to do with how we humans perceive information and how information has developed today. The fact is that we are more focused on the visual than on the written word, which is one of the many ways to show something visual.

• CS I find exciting what you just said in relation to visuality. Do you think we have reached a different audience than perhaps an audience that would go to see a science exhibition? Or how would you describe the audience? You are an art museum in the heart of Buenos Aires, so maybe you normally have a different audience or a specific audience?

• CB Yes, in any case, our exhibition has expanded the audience, we could see that immediately. Daniela and Valentina's event was on Wednesdays and Saturdays and you could tell from the number of people alone that it wasn't always the same people who came but also new ones. And I think the fact that you could find different points of contact was also a strength of the project. You could link it to art, or for someone who is more interested in science, to science, and those who are more interested in digital technology came for that reason. There were very different levels and points of contact. It was an enrichment for the audience and it was really well attended.

Fig. 4: Visitors exploring the VR experience with hand tracking and gestures

The exhibition was extended because it worked very well. And for me personally, it was important to see that there is a very traditional art audience that gets the opportunity to try out digital technology like VR, which they probably wouldn't have done otherwise. Equally, the institution in which this happens is important because it gives a kind of confirmation that this is culture, art, so to speak. So they accept it. It was interesting to see, for example, how a group of older women kept coming back several Saturdays in a row, who would normally, as we discussed with them ourselves, not have been interested in this at all. A scientific museum would not have interested them at all, but the fact that it was an art museum, which they regularly visit, changed their impression, and they told their friends about it. Every Saturday there was a large group of art fans of different ages, who you wouldn't necessarily expect to be interested in digital technology (fig. 4).

• CS I have another question about space. Our Berlin exhibition placed strong emphasis on the exhibition space, TA T, the veterinary anatomical theater. And that was also an important question for the exhibition's journey to the Museo Sivori, right from the start. Do you think that the location had an influence on the way the exhibition turned out? We found a special corner in the museum with strong light effects due to the sun's illumination of the structure. This also resulted in difficulties with the VR, as the hand tracking failed at times. How would you describe the relationship between the exhibition's realization and its location?

• CB I think it was a well-chosen location, especially because it became a bit intimate. It was open because the walls were made of glass and you could also see the beautiful garden. And I think that also had the effect of not feeling cramped. All the artistically woven webs around it could have created that feeling. With regard to what I said earlier, I think it was also important that the communication aspect was also very suitable. I don't think it would have worked as well in the large room, where the work also connects with other works. The exhibition was staged in an extra room, which is not actually a room, it was part of the corridor. We turned it into a hall and it was very important to have this intimate feeling.

• CS For me, this willingness and that we were able to do this at all was also really important. Perhaps this relates to the trust you mentioned in the beginning. In the end, crucial parts of the exhibition were literally stapled onto the walls. Of course, it was invasive, in a way, for the space, to say that you actually accept this damage to the museum walls in order to redesign and realize this space and really create an impact on the materiality of the space. It wasn't just hanging up and exhibiting things, but actually really changing the space through the installations, connecting the work with the space, that's what you accept.

• CB Yes, that was a very important part of the exhibition, also for the artist and for me, that through this networking there is also the idea of actually changing the walls or the space. That also has to do with the fact that we both have a lot of experience with installation and production and that we knew it had to do with the museum's trust, of course, but we also trusted our skills that we'd be able to undo everything afterwards.

• CS Thanks for the conversation, Chana.