Clemens Winkler

Atmosphere in the Making: Airborne Metabolic Pathways

> The circular wind created a vertical air curtain in the rotunda of the Veterinary Anatomical Theatre with its thirteen-meter diameter, whereby a stable climate emerged in the center. . . . Because the cloud in the center was irreproducible, the bodily experiences could only be made deeply personal. A continuously forming atmospheric event connected specific energetic, material, and residual effects with something not clearly seen, a dream-like compassion of an extended 'we'.

The collective curatorial project "Stretching Materialities: Hidden Activities in Objects and Spaces" 2021/22 brought an emerging cloud indoors. This enabled situated perspectives on becoming with water, energy, microbial life in the air, and its residues at a material and affective level. At a material level, these residues trigger questions about the physical composition and metabolic behavior of the cloud: How is the cloud formed? How is it accessible to whom, where and when? Moreover, at an affective level, how do we unintentionally deal with the cloud while constantly shaping our feelings within it?

Starting from the perspective of "in the making" to better understand the connections from trace gases and cloud formations to interactions with diverse actors, a participatory approach aims at new ways of perceiving compassion for human and nonhuman actors in increasingly precarious planetary environments. "In the making" explores the notion of dwelling within the intermediary realm and fostering corresponding in the design process, as demonstrated by Tim Ingold in his book on making.[1] Here, larger concerns across disciplines are added to open up the design process for ecological and future-oriented ways of making and participation in material practices and activities.[2] In a participatory opening for diverse nonhuman as well as human actors in the making, language in its complexity also plays an important role in thinking together implicit or explicit forms of being.[3] Consequently, language is regarded as

1 See Tim Ingold, *Bringing Things Back to Life: Creative Entanglements in a World of Materials*, NCRM Working Paper, Realities/Morgan Centre (University of Manchester 2008); see also Tim Ingold, *Making: Anthropology, Archaeology, Art and Architecture* (New York: Routledge, 2013).

2 Tim Ingold and Carolin Gatt, "From Description to Correspondence: Anthropology in Real Time," in *Design Anthropology: Theory and Practice*, ed. Wendy Gunn, Ton Otto, and Rachel Charlotte Smith (London: Bloomsbury, 2013), 141.

3 Joseph Vogl, "IV.2 Poetologie des Wissens," in *Grundthemen der Literaturwissenschaft: Poetik und Poetizität*, ed. Ralf Simon (Berlin: De Gruyter, 2018), 460–74, https://doi.org/10.1515/9783110410648-024.

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sense-making in both ways: sensually investigating constructive moments in the dense materiality of a drifting cloud full of living entities and particulate matter, while also critically, semiotically, or poetically proofing the precise wordings through making anew. This is also about reading atmospheric processes in their indeterminate symbolic nature to then critically examine a potential farming of uses in working with atmospheres and climate, similar to synthetic biology working on synthetic forms of life between highly distributed systems and very fine modes of sensing. Accordingly, careful handling between *sensing* and *estimating* plays an important role in dealing with volatile materials, such as air, water vapor, and aerosols or dust, soot, bacteria, and spores.

The Cluster of Excellence "Matters of Activity" (MoA) provided a framework for such investigations into atmospheres in the making. For the aforementioned exhibition project, the Object Space Agency (OSA) research group conducted a six-month, in situ, ongoing research process on "Stretching Materialities: Hidden Activities in Objects and Spaces" at the Veterinary Anatomical Theater (Tieranatomisches Theater, or TA T) in 2021/2022. In addition to coordinating the research group as a curatorial collective, my research was increasingly devoted to questioning the boundaries of various practices and figures of thought interwoven within them. Stretching the practices within the exhibition process encompassed questioning collecting and conservational practices to open up to ecological, technological, participatory, and political processes in contemporary exhibition contexts with visitors, exhibits, and the environment as active protagonists. The experiences gained in practice-led research ranged from methods on new bodily experiences, performative ways of notation, structural findings, and methods of fabulation, which allowed cloud beings, measurement types, and climate scenarios to emerge in negotiable ways.

The Act of Making Critically?

In the realm of making, there is an inherent potential for control, which presents its own challenges. To address these challenges, this article relates to the importance of focusing on the design process as part of embodied and situated knowledge, material agency, and culture.[4] The pursuit of adaptivity requires a critical and careful response to pressing issues such as climate change, extractivist capitalism, and cross-species living conditions that can be transmedially designed in an investigative world-making through material phenomena.[5] The element of control and activation through design

4 See Ingold, *Making*; Bruno Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1992); Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," *Feminist Studies* 14, no. 3 (1988): 575–99, https://doi.org/10.2307/3178066.

5 Together with Léa Perraudin, I have explored the relationality of care, control and proximity and reflected between the discourses of the humanities and research through practice-led design in terms of

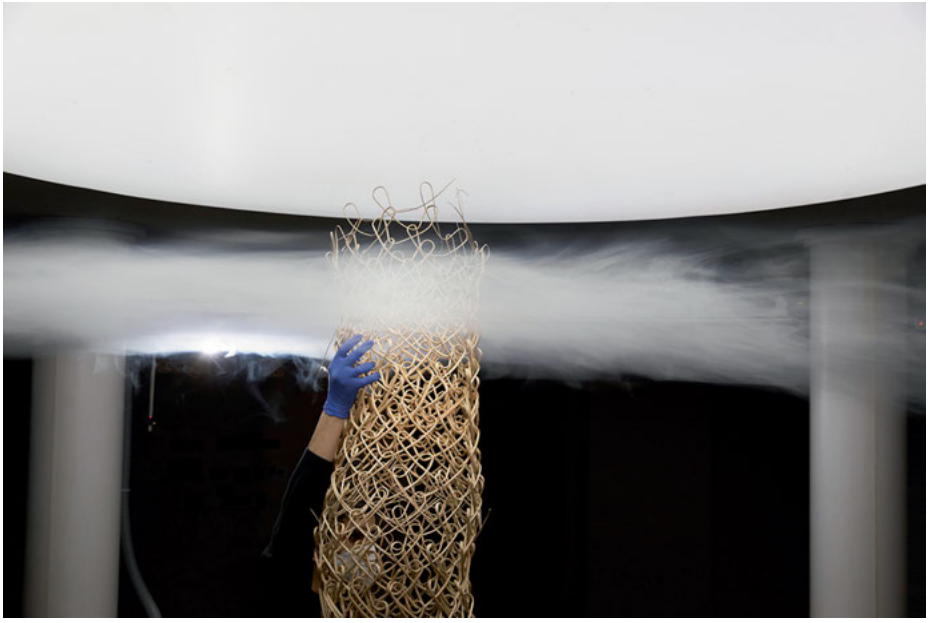

Fig. 1: The cloud at TA T responding to willow structures—with Natalija Miodragovic's Plektonik—Structural Textile.

is critically examined, while design knowledge is seen as tacit, personal, and context-dependent.[6]

As in the act of space-time dispersion as well as the merging of culture with nature in Western society, this text transforms what Karen Barad expresses through intra-acting in posthumanist philosophy or Donna Haraway's famous claim of "staying with the trouble" of the planetary condition into staying in the damp atmosphere of a cloud, which became a critical symbol for postmodernity.[7] Here, matter as condensation of

their shared and contradictory modes of investigative world-making. See Léa Perraudin and Clemens Winkler, "Designing with Care? A Pending Question," in *Material Trajectories. Designing With Care?*, ed. Léa Perraudin, Clemens Winkler, Claudia Mareis, and Matthias Held (Lüneburg: Meson Press, 2023) 15–29.

6 Claudia Mareis, Moritz Greiner-Petter, and Michael Renner, ed. *Critical by Design? Potentials and Limitations of Materialized Critique* (Bielefeld: transcript Verlag, 2022); see also Nigel Cross, *Designerly Ways of Knowing* (Basel: Birkhäuser, 2006).

7 See Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham, NC: Duke University Press, 2007), 133–39; Donna Haraway, *When Species Meet* (Minneapolis: University of Minnesota Press, 2008) and *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, NC: Duke University Press, 2016); Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton, NJ: Princeton University Press, 2015); Astrida Neimanis, *Bodies of Water: Posthuman Feminist Phenomenology* (London: Bloomsbury Publishing, 2017); Ewa Plonowska Ziarek, "The Rhetoric of the Cloud: Celan and the Sublime," *Critical Inquiry*

response is conceived as a sensing of air particles between phase transitions, which itself already extends the "how-to" logic for designing and making by an ongoing process of negotiation and interpretation in actu.

Thus, the following practice-led research proposes a state of co-constitutive weathering, or intra-weathering, as a starting point for entering new modes of environmentally sensitive designing.[8] Intra-weathering focuses on the inseparability of the entangled relationship between environmental phenomena and their reciprocal bodily constitution in sensing and measuring porous material boundaries, as well as the debris and residue as fertile ground itself for entangled biological, meteorological, structure-building processes.[9]

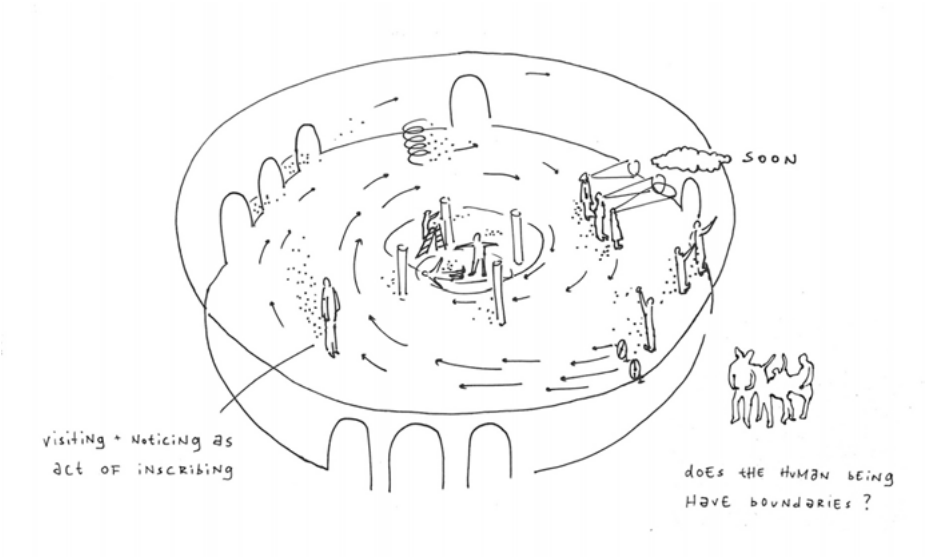

Fig. 2: Sketch of the exhibition space and possible ways of inscribing and loosening bodily boundaries.

Within this research practice, the political urge to make something is applied through the process of seeding and nucleating, which might bring us together with Tim Ingold's

28, no. 3 (2001): 634–71; Peter Sloterdijk, *The Art of Philosophy: Wisdom as a Practice* (New York: Columbia University Press, 2009); and Tung-Hui Hu, *Prehistory of the Cloud* (Cambridge, MA: The MIT Press, 2015).

8 Yolanda Ariadne Collins, "Weathering Weather. Atmospheric Georgraphies of the Guiana Shield," in *Weathering: Ecologies of Exposure*, ed. Christoph F. E. Holzhey and Arnd Wedemeyer (Berlin: ICI Berlin Press, 2020), 181–205.

9 Ted Krueger, "Microecologies of the Built Environment," in *The Routledge Companion to Biology in Art and Architecture*, ed. Charissa Terranova and Meredith Tromble (New York: Routledge, Taylor & Francis Group, 2017).

walk through "weather worlds" or Astrida Neimanis' "weather instructions."[10] In this exhibition context, event scores became an invitation for site-specific works, for sensing the impact of the self, and experimental spatial arrangements that follow towards an exploratory and participatory ground in practices of exhibition making, site-specific theater, and complicit knowledge production.

Making as understanding of self as well as inevitable third culture focuses in-between sciences and humanities on the emergence of *Gestaltung.*[11] From a critical perspective, it is essential to incorporate scientific methods and discursive views complementing the three perspectives of humanities, sciences, and architecture/design connected through various forms of making. By examining the modes of production in their scientific and cultural evolution, practices such as dismantling information, reassembling, and speculating offer critical insights into contemporary environment-human relationships throughout the disciplines.[12] As a result, three figures of practices evolved on a participatory exhibition stage with the indoor cloud: *enveloping* as designing new experiences, *mapping* through scientific tracking, and *fabulating* through conceptualizing and envisioning (fig. 3).

Designing Exhibitions as Investigative Research

A designing aspect of an atmosphere in the making is not carried out for a particular purpose from the beginning but rather in the process itself, where one's mind and body are exposed directly as barometers and thermostats standing in and shaping physical environments. Here, already before the actual process of an indoor cloud formation, there is a chance to witness ordinary material trajectories and metabolic pathways to open further important perspectives of making and designing as an intersectional, environmentally conscious and cautious practice of care.[13] It includes attentive experimentation and practical tinkering engaging with the material world in a non-

10 Tim Ingold, "Footprints through the Weather-World: Walking, Breathing, Knowing," *Journal of the Royal Anthropological Institute* 122 (2010): 121 – 39, 122, https://doi.org/10.1111/j.1467-9655.2010.01613.x; Astrida Neimanis and Jennifer Mae Hamilton, "Weather," in *Connectedness: An Incomplete Encyclopedia of Anthropocene*, ed. Marianne Krogh (Copenhagen: Strandberg Publishing, 2020).

11 Wolfgang Schäffner, "The Design Turn: Eine wissenschaftliche Revolution im Geiste der Gestaltung," in *Entwerfen—Wissen—Produzieren,* ed. Claudia Mareis, Gesche Joost, and Kora Kimpel (Bielefeld: transcript Verlag, 2010).

12 Helmut Kreuzer and Wolfgang Klein, ed. *Die zwei Kulturen: literarische und naturwissenschaftliche Intelligenz; C. P. Snows These in der Diskussion.* (München: Dt. Taschenbuchverlag, 1987); Claudia Mareis, *Design als Wissenskultur: Interferenzen zwischen Design- und Wissensdiskursen seit 1960* (Bielefeld: transcript Verlag, 2011).

13 Claudia Mareis and Nina Paim, ed., *Design Struggles: Intersecting Histories, Pedagogies, and Perspectives* (Amsterdam: Valiz, 2021).

normative form of ethical obligation.[14] In turn, this inquiry follows from the intra-weathering of objects and bodies against the backdrop of conservational practices in museums, theatre and archives as the potentiality of tracing clouds as an indicator for cautious practices. The making of certain atmospheres, specifying clouds, and experiences built upon my own previous projects in contexts such as laboratories, classrooms, volcanic sites, and high-altitude locations.[15]

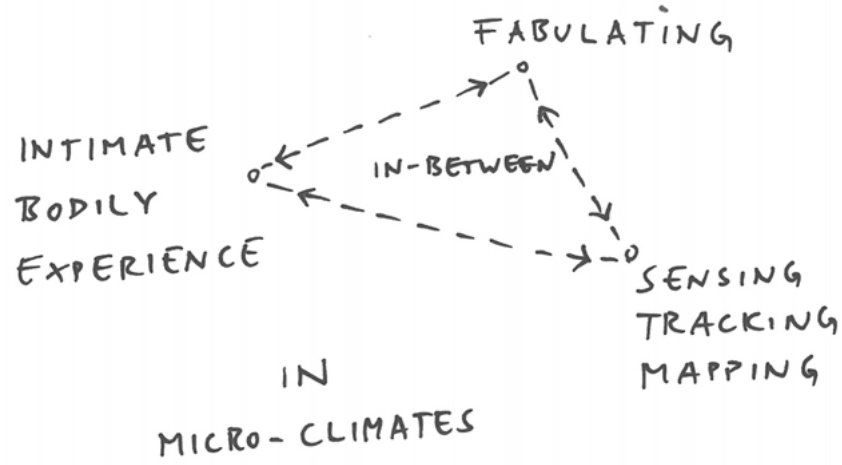

Fig. 3: Triangular diagram reflecting on emerging practices in the experimental situated exhibition context.

Why clouds as indoor atmospheres in the first place? Clouds are described as transformational states of water, particulate matter, and air that undergo phase transitions and precipitation processes. Given that clouds can only be seen as a visible condition of aerial events with their extreme peculiarities on the natural site, like abrupt phase shifts in so-called super-cooled conditions or turbulences that actually stabilize complex thermodynamic structural-functional relationships, for this research using wind, airborne dust, energy in- and output and vaporized water became the tools for testing and crafting. Consequently, the exhibition space in fig. 2 became a testbed for experiencing cloudiness, exploring the impact of changes in the physical atmosphere on human perception, and engaging with the natural and cultural history of creatures and other non-human bodies. The investigation of the atmosphere thus brought together mediating

14 María Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: University of Minnesota Press, 2017).

15 Clemens Winkler, "Per-Forming Clouds—Materielle Dynamiken als Kommunikationsmodelle," in *Matters of Communication—Formen und Materialitäten gestalteter Kommunikation*, ed. Sabine Foraita, Bianca Herlo, and Axel Vogelsang (Bielefeld: transcript Verlag, 2020).

qualities of various materials and the composing materials of media as environing media in climatic environments.[16] The aim was to experimentally sense and make with different forms of liveliness and stimulate interdisciplinary thinking around who or what might be materially active.

Figures of Practices

After situating a debate around critical making of and with atmospheres, the three disciplinary angles of sciences, humanities and designing particularly within a participatory exhibition project as a testbed for research, three figures of practices emerged. The first figure—enveloping—involves shaping the conceptual understanding of cloudiness by practical designing methods for sensorial experiences and new intimacies. The second approach—mapping—influences the understanding of cloudiness in situ by employing scientific methods of microbial air sampling and thermal investigations. The third approach—fabulating—attempts to understand cloudiness through discursive reflections and imagination, allowing for the emergence and disappearance of damp haptic atmospheres. As a curatorial collective, our research group focused on making aspects of the atmosphere inside the TA T, leading to attunement to specific air conditions and atmospheric qualities. Through experimentation, we engaged in critical ways of collecting, sampling, and mapping techniques, critically giving a voice to microbial companions, mineral or wet residues, bioindicators such as lichen, or even trace gas concentrations of carbon dioxide or sulfur oxide, which—with humidity—become weathering agents to certain surfaces in the indoor environment of TA T.

1. Enveloping. As conceptualized by Derek McCormack, atmospheric envelopments offer a productive framework for understanding the differential shaping and fabrication concerning atmospheric milieu, complicating the notion of inhabiting as a neutral passive act.[17] Understanding an active enveloping also fundamentally precludes complete control of atmospheric dynamics and questions how we engage in formless processes through the contingent capacity to sense and respond. The close link between atmosphere and technical control in this experimental project required critically examining the conditions for the emergence of particular microclimates in the exhibition space. Drawing on what anthropologist Timothy Choy calls "haling," this practice raised awareness of the changing indoor microclimate for which we are co-responsible, as participants, co-makers as well as so-called weather-ers.[18]

16 Adam Wickberg and Johan Gärdebo, ed., *Environing Media* (New York: Routledge, 2023).

17 Derek P. McCormack, "Elemental Infrastructures for Atmospheric Media: On Stratospheric Variations, Value and The Commons," *Environment and Planning D: Society and Space* 35, no. 3 (2017): 418–37, https://doi.org/10.1177/0263775816677292.

18 Clemens Winkler, Léa Perraudin, and Iva Rešetar, "The Body of Breath: Morphologies of Air Movement," in *Atem/Breath*, ed. Linn Burchert and Iva Rešetar (Berlin: De Gruyter, 2021), 87–88.

The inscription of the atmospheric milieu and dimensions of weathering into the built site of the TA T occurs for reasons of preserving and exhibiting its "stabilized" or even passivated interior activities. The question arose concerning which institutional systems, tools, and infrastructures shape our relationships with atmospheric conditions' passivated materials and concerns of liveliness and activity in this practice of enveloping.[19] Why is it essential that exhibition sites take care of such dealings with ecological spheres or forms of contemporary response?[20]

The first step of investigation for this purpose was to provide a framework that enabled exploring certain airy conditions. This was set to bundle air in the rotunda, the former dissection area of the TA T with its thick masonry and small windows built in 1790 to keep the horse cadavers cool for the sake of anatomical research practices. In the exhibition context, two wind machines were installed to create a cyclonic motion of air with the eye of the storm in the center, where the former elevator for the horse corps was installed to bring bodies of research into the upper atrium. From here, in the exhibition, particles from visitors, objects, and built materials as contributors—inscribed unintentionally through residue—gathered in a stabilized climate. The circular wind created a vertical air curtain in the rotunda of the Veterinary Anatomical Theatre with its thirteen-meter diameter, whereby a stable climate emerged in the center. As the next step, a stable climate layering was installed in the center with a warm, dry air layer on top, a damp layer in the middle, and a colder, drier bottom layer. The creation of an indoor climate with diverse cables, relays, controllers, physical heating, cooling, and moistening engines looked different compared to how microbes or natural hygroscopic materials[21] would transform air quality.

As a result, a forming cloud could be observed as an accumulated object of condensation nuclei from the environment, where the leakage of objects, materials, and the occurring dust particles seemed to meet the condensation of water vapor and thermal transitions. In the context of this experimental design and collective exhibition work, the cloud was a differentiated process of "envelopments" and deeply interwoven with the objects, microbial organisms, visitors, researchers and cleaning staff of the exhibition (fig. 4).

From a climatic and biological perspective, through breathing, body heat, and debris, the visitors were directly conversing with the installation: they tore holes into the cloud and changed its flow and structural differentiations through physical move-

19 Mark Jarzombek, "Haacke's Condensation Cube: The Machine in the Box and the Travails of Architecture," *Thresholds*, no. 30 (2019): 98–105, https://doi.org//10.1162/thld_a_00292.

20 See the Museum for Climate Action website, https://www.museumsforclimateaction.org.

21 Compared to a space full of olivine stones hygro-scopically digesting CO_2 in a so-called enhanced weathering process. Only the time scales are different to work with in a human life. James Temple, "How Green Sand Could Capture Billions of Tons of Carbon Dioxide," *MIT Technology Revie*w (2020), https://www.technologyreview.com/2020/06/22/1004218/how-green-sand-could-capture-billions-of-tons-of-carbon-dioxide/.

ment.[22] The cloud raised the question of where to find agency and a new way of being. A cloud is inherently a place for encounters of a material nature: human, ecological, social, and affective spheres of emergence.

Because the cloud in the center was irreproducible, the bodily experiences could only be made deeply personal. A continuously forming atmospheric event connected specific energetic, material, and residual effects with something not clearly seen, a dream-like compassion of an extended 'we.' The cloud was intimately tied to notions of sublime mental worlds and alienated realities; however, at the same time, in this example it also becomes the result of technical operations between caretaking and extraction. How can we more actively shape our understanding by better experiencing the dialogue with various emerging bodies of air, as a metabolism of energy, material, work, and exhaust through envelopment?

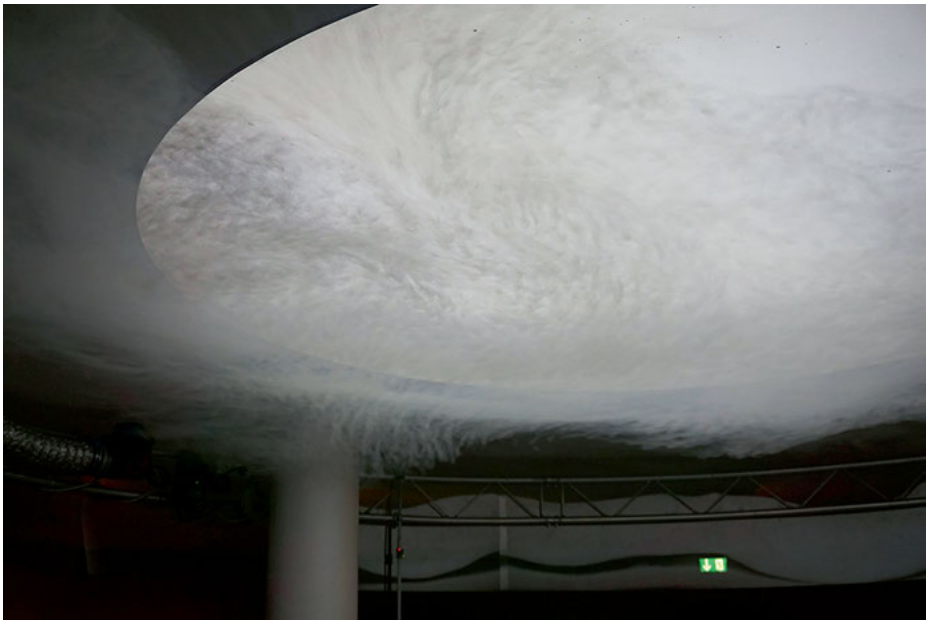

Fig. 4: Participatory cloud installation in the making.

2. Mapping. There are airborne particles—dust, debris, residue, and sediment—in every indoor environment. Outside, the nucleation of clouds and weather formation depends on the particles in the air. As residue, dust is carried within the space as a nucleator and occupies any surface level. Furthermore, it is the base for indoor micro-ecologies. How can we deal with dust? In this mapping practice, tools such as

22 Ingold, "Footprints through the Weather-World," 122.

air samplers helped to analyze and archive living and nonliving air particles regarding participatory indoor events, such as tours and workshops (fig. 5).

In addition, the tracked number of visitors, taking dust samples weekly with the cleaning staff and settling dishes, and the pH value of outdoor filtrated water helped to complement the sampling concerning surrounding influencing factors. The experimental investigation of the practical questions of dealing with and living with the indeterminacy of residues and climatic tracing led to a testing series. For instance, a taxonomy of dust evolved when visitors brought in soil bacteria such as *Bacillus subtilis* through their shoes, and security staff unintentionally let pollen inside the building during the COVID-19 lockdown.

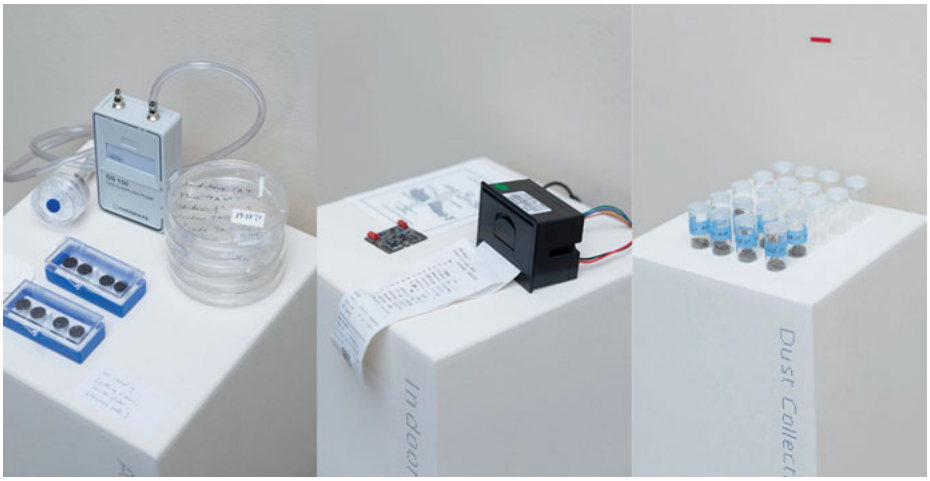

Fig. 5: *From left to right: settling dishes, microscopic plates with collections of biotic, abiotic, anthropogenic dust residues for SEM imaging; weekly dust samples collected with cleaning staff at Tieranatomisches Theater (TA T).*

As water is an immanent companion of airborne particles and almost any environment on our planet, it was included in our exhibition site at TA T for the purposes of cloud nucleation. The nearby river Kleine Panke recalled 200 years of penetration of the surrounding built environment, changing sediments, and micro-topographies on the site. By including the river- and rainwater into the exhibition, the soul of the Kleine Panke was brought metaphorically back into the "waterproof" building to make friends again with indoor air, microbiota, and overcome historical ghosts, thereby becoming a symbol of reenactment and healing practices in the former slaughter hall (fig. 6). From here, making as caretaking was related to sensing and fabulation as well as measuring, mapping, and form-giving. Material residues were captured and made visible in new states through the addition of water, energy, and labor performed (figs. 7, 8).

3. Fabulating. Due to experiencing different atmospheric material activities in the experimental exhibition space of the TA T, sampling and mapping certain conditions, the method of fabulating became useful to think of alternative treatments and changes in the situations between objects, humans, and spaces. Given that a new state for air assemblages was imaginable, a speculative archive of ideas and debates was tested based on a series of measurements and first physical experiences and brought onto the wall of the rotunda space at TA T. Like the airborne living and nonliving particles mentioned earlier, they call for empathy regarding other strange airborne assemblages or microbial films to grow in what we consider to be harsh conditions. Further assemblages of skin cells, textile fibers, and lactobacilli were found through sampling in the space and brought imaginatively into undesirable and desirable climatic scenarios, where heavy metals or high levels of sulfur and carbon emissions surrounding the exhibition site could become nutritious for certain airborne species to metabolize into new forms.

Fig. 6: *Environmental modes of making indoor atmosphere, from left to right: filtration diagram of the river Kleine Panke into the exhibition space with Dimitra Almpani-Lekka.*

The accommodated participatory formats, seminars, and workshops in the exhibition space were titled "Imagining Suspended Care-iers," asking the following questions for opening design processes through shared education: How can cross-species design offer more inclusive methods of climate action? What can we learn through the lens of air-traveling particles in the environment? How can we create access points to other species by designing material objects, exercising forms of embodiment, and short movie essays?

Fig. 7: *Speculative archiving 1: Timeline of aerial samples of dust, microbiome, visitors, thermal conditions.*

Techniques such as templates for protocoling and event scores helped to follow up specific workshops, seminars, and public formats. As a co-designing practice and a cross-species designing approach, participants left notes and sketches in the exhibition space about individual air futures, geo-stories, and microclimate fictions. Drawing from the experiences with the indoor cloud, it called for re-attaching to bodily sensations of dampness, heat, and drought and changing the language towards probable modes of

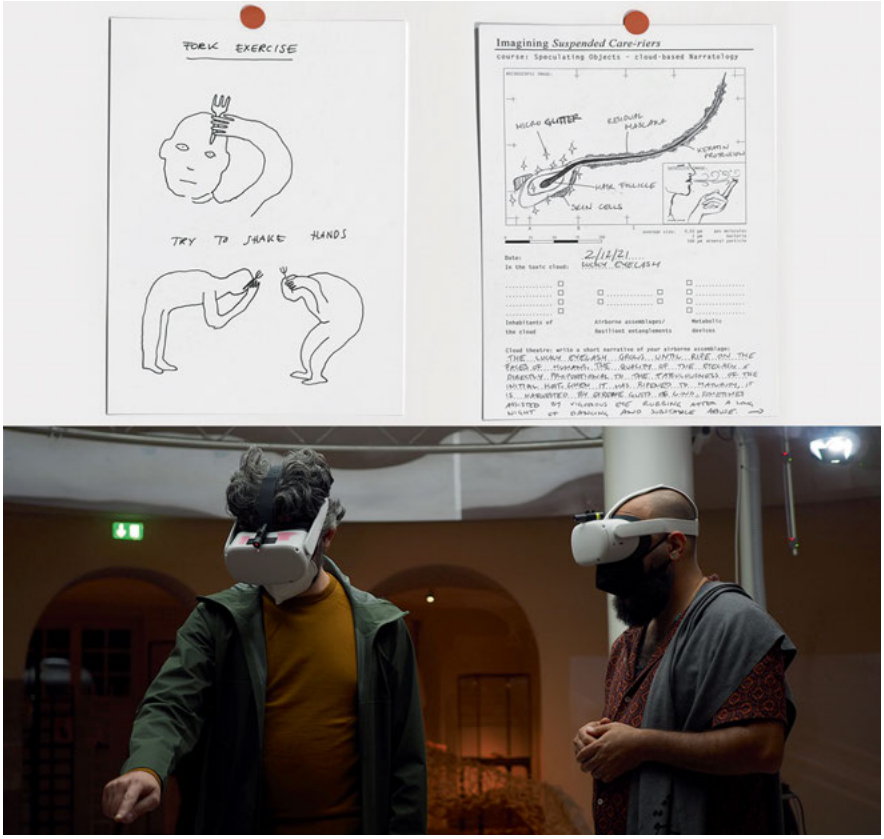

Fig 8: *Speculative archiving 2: Participatory research methods on imaginary aerosols/embodiments, event score, VR experimentation.*

attunement[23] and material futures of acceptance, caretaking, and healing. As a figure of practice, fabulating thus enabled diving back into the other figures of enveloping and mapping.

23 Experiences and knowledge related to humidity, heat, and dust levels, as well as the dust sampling and classification process at TAT were effectively shared and transferred. As part of three lectureships, I had the opportunity to engage with institutions like the University of Buenos Aires in the "Master Open Design" program, the IDK design department at University of the Arts Berlin, and the MA program "Spiel und Objekt" at the University of Theatre Arts Ernst Busch Berlin.

Figures of Thinking in the Making

These three figures of practices—enveloping, mapping, and fabulating—resulted in reflection on recurring conceptual challenges in a triangular dance of agency.[24] With the importance of language use for ways of knowing and experiencing critically, further investigating as stated at the beginning led to the incorporation of designerly thinking. Through exercises aimed at broadening the scope of making to encompass participatory exchange and larger socio-ecological contexts in fabulating, the concept of indeterminacy frequently emerged, highlighting the role of contingency in designerly thinking. Another concept—which we might call a "figure of thinking"—involved debating the exhibition space's cloudiness, considering its various residues and their liveliness. The next figure of thinking—scalability—grappled with questions from mapping exercises, which involved interpolating investments and investigations made during the designerly mock-up of the testing ground for bodily envelopments. This process also traced excavated energy and water resources outside the TA T, along with airborne microbes originating from plant pathogens, which were found far outside Europe but ended up in the exhibition space.

1. Indeterminacy. As earthlings, we are always in an atmosphere, whether in rough weather (extramural) or affordable passivated indoor climate (intramural).[25] We are immersed on a microscopic level in gas envelopes surrounding our planet. Therefore, we are in constant exchange with the environment, weathering and leaking into it and being affected by the atmosphere, forming it, and becoming informed. Embracing leakiness challenges notions of contamination and containment, blurring the boundaries between liveliness and non-liveliness.[26] How can we make new intimacies with ambiguous and indeterminate matter when we are always leaking in an atmosphere? What language can design practices offer to raise awareness of these relations? The epistemic potential of leaking is not a dematerialization or a drift into the diffuse, but—on the contrary—a concretization and disclosure of a profoundly material event. Otherwise, one

24 Performative dance as practice of epistemic acting between the lab and the environment in Andrew Pickering, "Being-in-the-Environment: A Performative Perspective," *Dans Natures Sciences Sociétés* 21, no. 1 (2013): 77–83, https://doi.org/10.1051/nss/2013067.

25 The atmosphere can be understood here metaphorically through language, there is "something in the air," expressing a vague qualitative something. The making of atmospheres from a psychological/sociological perspective follows Tellenbach and Boehme's latest socio-ecological framing of the concept of atmosphere as a question of who owns ecology when there can no longer be such a thing as mere nature. Federico Vercellone and Tedesco Salvatore, ed., *Glossary of Morphology: Lecture Notes in Morphogenesis* (Cham: Springer, 2020), 45–46. However, the handling of the indeterminacy of *atmosphere* shall be dedicated to microbes as an example to incorporate a nonhuman-centric view on matters of aerial activity.

26 "Materials—no matter how solid and inert they may seem—have the tendency to change sooner or later, to leave the place assigned to them, to mix, to form new connections or to dissolve." Tim Ingold, *Being Alive: Essays on Movement, Knowledge and Description* (New York: Routledge, 2011), 16.

would assume that materiality is an inert, passive, and resistant raw material for formal design. Therefore, contrary to a tendency towards dematerialization, working with air and fog involves a tightening of objects in the process of becoming. In this way, the physical world of hardware can be grasped through indeterminacy, continuously prompting us to ask: Where are we now? How do we locate ourselves now as leaking bodies? What language might help us to navigate anew through microclimates, bodily and mentally, in intimate and planetary haling?[27]

For designers, air is a design medium that is non-visual, preventing it from capturing our imaginations, despite triggering new forms of it. Therefore, some strategies are needed to bring the *atmosphere* into focus, to wrest something tangible from the vastness, invisibility, and complexity of this abstraction. What could constitute experiments on the materiality of the air that would help us to shape its imaginaries?
A *making-with-atmospheric condition* and a suitable language connecting theory and practice can be formed due to what Lucretius called nephological production as part of meteorology.[28]

Hippocrates—the son of Heraclides—held that humans were attacked by epidemic fevers when they inhaled air infected with dusty pollutants that are hostile to the human race. Further, in about 55 BC Lucretius called in the fields of meteorology and nephology—the study of clouds—to observe "the dance of dust particles on a sunbeam in a darkened room and concluded that their movement must result from a bombardment by innumerable, invisible, moving atoms in the air." This brilliant intuition enabled him to account for many interesting phenomena, including the origin of diseases.[29] The dust in its dance could be seen and understood as many forms, as "dust language." Developing a dust language, observing the shifting boundaries of people, objects, and environments was investigated in the practical part of enveloping, mapping, and fabulating.

This perspective still allows us to think of air as being dense and full of activity. Following Lucretius, it took another 1,500 years for scientists to discover the diversity and metabolic forces in airborne particles.[30] Indeed, it might shed new light on what

27 Cultural anthropologist Timothy Choy asks whether "we" are talking right now, grappling with implications. "We" depend on, share, and respire and also affect each other's atmospheric surroundings, including the air. "Ecological Reparation: Museum of Breathers," YouTube video, 11:55, December 1, 2021, https://www.youtube.com/watch?v=CxpGrdXey50.

28 As a branch of meteorology, nephology (from the Greek word *néphos* for "cloud") was the study of the clouds. The British meteorologist Luke Howard established a cloud classification system in his 1865 paper *Essay on the Modification of Clouds.*

29 Maureen Lacey and Jon S. West, *The Air Spora: A Manual for Catching and Identifying Airborne Biological Particles* (Dordrecht: Springer, 2006), 16–17.

30 "The belief in 'spontaneous generation' of organisms causing decay and disease was held by many people and persisted for a couple of centuries. Micheli (1679–1737) was a botanist in Florence who, by putting spores of molds on slices of fruit, showed that they were 'seeds' of the molds. As some control slices became contaminated, he concluded that spores of molds were distributed through the air (Buller, 1915). In his letters to the Royal Society in 1680, Anton van Leeuwenhoek reported that he was able to

can be understood by "contamination" today in spaces such as cleanroom labs, bio labs, fermentation facilities, food plantations, and public institutions.

2. Liveliness. After seeing formation processes and anchor points in strolling inside of indeterminacy of the exhibition space in the Veterinary Anatomical Theatre, how do we investigate other-than-human species dealing vivaciously with orienting and acting in air matters and atmospheres? As recent human endeavors involving new technologies, the first air samplers thirteen kilometers above the ground are detecting airborne microbial activities rendering clouds as being biologically active.[31] It starts to prompt speculation about rendering harmful anthropogenic organic compounds carbon dioxide and methane not as hazards but rather as nutrients. Therefore, it is known that metabolic activities by airborne bacteria in suspension make clouds of the tropos- and atmosphere a lively place on our planet digesting in the same manner as on the litho-, hydro-, and biosphere and living with—for instance—carbon, nitrogen, or sulfur cycles in the air. This perspective might be seen as a consequence of a contemporary attunement to atmospheric conditions.[32]

Computing these complex data models as a benchmark of digital processing is based on thermal layering, metabolic processes, and electromagnetic radiation to be mapped out in situ, from the ground, from inside, and from space. In the future, it is both expensive and uncertain whether we will be able to effectively study and understand the microorganisms present in the air, because the air has low density, significant temperature variations, fast movements, high volatility, and a considerable amount of radiation. These factors create technical challenges and stress that make it difficult and questionable to map the microbiome of the air and study its activities in a comprehensive manner.

We found fungal spores attached to grains of sand in the exhibition space by sampling and mapping. Another tiny actor within the exhibition was the bacteria *Pseudomonas syringae*, a plant pathogen that is also found in the upper troposphere and stratosphere. It cleverly deals with the oddity of phase transitions in water. On the

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see minute organisms with his handmade lenses; he later came to suppose that 'animalcules could be carried over by the wind, along with the bits of dust floating in the air' (Dobell, 1932)." Lacey and West, *The Air Spora*, 17.

31 Devices such as the Aircraft Bioaerosol Collector (ABC) system on the NASA C-20 A aircraft. David J. Smith et al., "Airborne Bacteria in Earth's Lower Stratosphere Resemble Taxa Detected in the Troposphere: Results from a New NASA Aircraft Bioaerosol Collector (ABC)," *Frontiers in Microbiology* 9 (2018), https://doi.org/10.3389/fmicb.2018.01752.

32 "[T]he global-scale transformation to which the anthropocenic moment is tracked is 'nowhere more evident than in the atmosphere' (Will Steffen, Paul J. Crutzen, and John R. McNeill, 2007, 616), . . . and this massively circulating designation of a human moment can be read not simply as the act of a sovereign and anthropocentric science but as a painstakingly developed attunement to an air condition." Timothy Choy and Jerry Zee, "Condition—Suspension," *Journal for Cultural Anthropology* (2015): 210 – 23: 217, https://doi.org/10.14506/ca30.2.04.

ground, it likes to break off plant surfaces through ice crystallization to reach inner plant structures by releasing a protein as nuclei and therefore forcing water to freeze above 0° C.[33] If stronger winds catch it and lift it into the troposphere, it travels transcontinentally on a grain of dust. Finally, it gathers in the air and potentially controls the crystallization of water again into ice crystals to force so-called bioprecipitation and colonize new parts of the planetary environment, reflecting just one of many vibrant stories from the air and the exhibition space.

Again, other-than-human metabolic perspectives join approaches, questioning the human as a central force. However, for scientific investigation, other questions might be more pressing, such as who owns and profits by fostering metabolic processes in today's *atmosphere* by learning from airborne bacteria, seeing them as swarms of tiny metabolic machines. This was an important focus of the practices section on mapping and fabulating.

Connecting to high-tech solutions, it is even more interesting to note that 150 years ago, in 1854, Christian Gottfried Ehrenberg—the founder of the emerging field of aerobiology—called for the vitality of atmospheres and analyzed and classified collected dust particles as residues in his publication *Mikrogeologie.* He brought up categories of dust early on: biotic (pollen), mineral, and anthropogenic. Extraterrestrial dust is also measured today, which was also relevant for discussions in the exhibition space. Ehrenberg also presented three central principles of microbial activity: *growing* under suitable conditions, *inhibiting* during unsuitable situations such as on atmospheric flights in the stratosphere, and *decaying* due to community behavior or unsuitable conditions.[34] This is wonderful if one thinks of this as a potential for a designing-with approach to the liveliness of materiality overcoming passivating materials per se (fig. 9).

In her research project on microgeology and aerobiology at the Bundesanstalt für Materialforschung und -prüfung (BAM) for the Federal Ministry for Economic Affairs and Climate Action, our research colleague Anna Gorbushina described how dust collected by Charles Darwin was revived by her research team in 2008. Darwin collected residues from the sail of the Beagle while sailing near the Cape Verde Islands, and sent dust samples to Ehrenberg in 1846 to become part of the collection at the Museum für Naturkunde Berlin. Gorbushina and her team proved how inhibited spores at the Ehrenberg Collection of the museum were still able to grow while being attached to transatlantic dust particles 150 years later, forming biofilms with distinct colors of melanin and carotene. The latter pigments helped the spores to cope with high radiation levels in the stratosphere. Comparing this impressive microbial ability to humans being ex-

33 Ravindra Pandey et al., "Ice Nucleating Bacteria Control Order and Dynamics of Interfacial Water," *Sciences Advanced* 2, no. 4 (2016), https://doi.org/10.1126/sciadv.1501630.

34 Christian Gottried Ehrenberg, *Mikrogeologie: Das Erden und Felsen schaffende Wirken des unsichtbar kleinen selbständigen Lebens auf der Erde* (Leipzig: L. Voss), 1854–56.

Fig 9: *Ehrenberg's illustration of dust collected by Charles Darwin on the Beagle* offshore Cabo Verde (at 17° 43N 26°W), January 1833.

posed to harsh—what we often call extreme—conditions hints at inhibition rather than growth or decay as an important principle of sustaining life.[35]

In comparison to satellite-sensing technologies to read out microbial journeys in the sky, Gorbushina and her research team further scratched local stone façades, e. g. of cultural heritages, to reveal colors of the biofilms woven by little microbes, depending on their flight duration and pathways. Melanin and carotene levels on the cell membrane can be seen as an analog approach to tracing microbial life besides satellite imaging techniques.

What are further adequate steps in tracing and understanding different forms of liveliness for and with exhibition sites in the making?

3. Scalability. The complication of such questions and the limits of scale lies at the heart of performing and understanding these processes of co-creation, requiring refined modes to account for our work as designers and scholars.[36] How does the contemporary human experience of smog and dust relate to various scales of airborne activ-

35 Calling extremophiles from a human perspective, surviving temperatures underneath -80° C, or high levels of UV radiation in stratospheric altitudes above 10 km; Anna A. Gorbushina et al., "Life in Darwin's Dust: Intercontinental Transport and Survival of Microbes in the Nineteenth Century," *Environmental Microbiology* 9, no. 12 (2007): 2911–22, https://doi.org/10.1111/j.1462-2920.2007.01461.x.

36 Anna Lowenhaupt Tsing, "On Nonscalability: The Living World Is Not Amenable to Precision-Nested Scales," *Common Knowledge* 18, no. 3 (2012): 505–24.

ities interacting with climates, pollution, and exhaust? Based on Lucretius's thesis, nowadays researchers can investigate the extent to which one particle affects or connects to another particle through different scales. Nevertheless, it still allows us to think of air as dense and full of activity. What remains is a space filled with life. Focusing on air activity makes tracing different forms of liveliness across scales feasible, enabling us to understand and embody larger relationships and entanglements from the dust in front of us.

How can one scale of atmospheric phenomena connect to other scales, starting with soil moisture and vegetation at surface levels? How is this related to smaller scales of molecules of trace gases and the formation of dust particles up to the formation of cloud droplets, and even a larger scale of wind patterns, and planetary circulation patterns? In the framework of TA T, I showed how an activity is connected between the different scales of air: microbial activities, energetic states in a tangible cloud towards a better understanding of intercontinental weathers. Dust connected the nanoscopic world of molecules with the macroscopic world of human operations. What is the order of magnitude hereby?[37] Moreover, what are further references for measuring beyond what has been done in the cloud at TA T?

The exchange and travels across scales shift interfaces between human and environment, subject and object, and therefore the physical cloud as a condition of material and human activity in an experimental exhibition site. The direct involvement in certain conditions with other materials and species as companions in one atmosphere also bridges between scales into stratigraphic imaginaries.[38]

Concluding Remarks

In the open process of making, the TA T became an experimental laboratory for testing interactions of space, objects, humans and new technologies in the atmospheric milieu. The investigative design research incorporating scientific techniques and theatrical practices on various airborne nuclei can contribute to a proclaimed new culture of the material in this publication.

Here in the exhibition space of the Veterinary Anatomical Theatre, the ordinary material air is negotiated by various agents, vaporized and condensated, declared the object of empirical research, embracing what remains out of control. The demonstrated practical and theoretical figures of investigation opened the liveliness of making in atmospheric conditions, observations of clouds as boundary objects, and re-en-

37 Jens Soentgen and Armin Reller, *Staub—Spiegel der Umwelt* (Munich: Oekom Verlag, 2005), 124.
38 Astrida Neimanis, "Water a Queer Archiving of Feeling," in *Tidalectics*, ed. Stefanie Hessler (Cambridge, MA: MIT Press 2018), 191–95.

acting on residual leftovers as embodiments of knowledge production through empirical research.

In situated ways, certain atmospheric conditions in the cold indoor environment of the TA T—built for conservational purposes—led to various cloud formations, which carried particles of visitors, exhibits, and the building as nuclei for water condensation and energy exchange. Thus, atmosphere in the making led to understanding the exhibition side as a metabolism that was continuously negotiated by mapping, experiencing, and imagining.

In what we might call metabolic archiving, critical design epistemologies were formed not statically but performatively in the sense of constant exchange between figures of practice and thought. As a goal, iterative participatory formats within the indoor cloud were integrated to create new conditions for shifting from emotions such as fear or defeatism to acceptance, active listening, empathy, and caring.

This contribution ends with a call within "Matters of Activity" for transdisciplinary practices to think and feel various climatic conditions, forms of liveness and steadiness within ephemeral media and an invitation to observe and experience a walk through a body of air, vapor, and residual leftovers. The heightened sensitivity inside a cloud allowed us to imagine the powerful metabolic force of a cloud's microbiome, to comprehend entire ecosystems in their threat from humans even in the sky, which sooner or later flies back at us. What do we perceive? What do we associate with it?

The experimental, situated, and open archival approach, the cloud and winds in TA T, paired with the figures and forms of the practices described above, can be brought into the present as a site-specific theater for re-enactments of archiving. At the same time, it allowed for practical, experimentally guided pre-enactments with the forming material, energy, labor, and residue in metabolic exchange for speculative environments.

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