InBetween: material encounters in human/non-human interactions

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InBetween is a collaborative interdisciplinary PhD research project situated at the intersection of architecture, textile design, and interaction design. The project explores sustainable forms of future life and seeks to identify bionic principles so as to create alternative lightweight building structures using textiles and digital fabrication techniques. This paper adopts a "designerly" (Cross 1982) approach and collaborates with various experts in three different settings at the Open Innovation Lab (OIL). It constitutes a piece of hybrid research in that it combines an alchemical "Wunderkammer" (curiosity cabinet) (Leibniz 1600; Munster 2006), i.e., "the old science of struggling with materials, and not quite understanding what is happening" (Elkins 2000, p. 17), with modern forms of collaborative investigation and with tool-making from science laboratories. This paper addresses the potential for holistic experimentation in interdisciplinary collaborations based on embodied experiences and ideas. These come into existence through – rather than are excluded from – an aesthetic engagement with emerging material technologies and with materials research for designerly application. Such serendipity in interdisciplinary collaborations opens up a space beyond disciplinary framings, where researchers can step back from purely disciplinary methods and perspectives and engage in a collaborative space of future possibilities.

Keywords: emerging material technologies; interdisciplinary collaborations; embodied engagement; epistemic action; serendipitous discoveries

1.0 Introduction

InBetween is a research venture at the intersection of architecture, textile design, and interaction design. It speculates on sustainable forms of future life in critical future scenarios and experimental prototypes. The project investigates the cultural and social locations of novel materials and technologies in an interdisciplinary, collaborative setting. It is informed by radical case studies (1960s–1980s) on soft architectures like Archigram, Buckminster Fuller, Cedric Price, or Yona Friedman. It also draws on critical theory on new materialism, (Haraway 1997, Barad 1998, Bennett 2007), and on the work of various sociologists, philosophers (Latour 2005, Deleuze & Guattari 1987), and phenomenologists (Malafouris 2005, Rancière 2004, Massumi 2002, Bourriaud 2002, Merleau-Ponty 1963). The intersection of textiles, "smart" materials, digital fabrication techniques, crafting techniques, and bionic principles for self-bearing properties seeks to investigate alternative building structures. While these are designed to have minimal weight, for instance, by using light materials, they shift the focus from performance and durability, categories typical of an engineering approach, to aesthetic qualities and to interactions between those novel materials in relation to the body. The research presented here recognizes the increasing need to explore new material possibilities and new technologies for their relational, interactive, and cultural potentials for embodying the design of future living environments. On the one hand, InBetween aims to foster innovative, new linkages and to recombine techniques, materials, and processes to foster the potential co-emergence of new materials, new design processes, and new methods. It does so using practices of making based on experiments involving "smart" (prosthetic), performative materials, digital fabrication, and analogue crafting techniques. The prototypes are tested with expert communities, students, and project participants. On the other hand, this research attempts to advance critical and artistic approaches that conceptualize materiality more actively and more performatively. The developed prototypes and probes prospectively seek to offer an experimental platform situated at the intersection of art, the economy, and urban planning. The ultimate goal is to open up a practical and tangible space for thinking about sustainable forms of future living.

InBetween focuses on the embodied engagement with "smart" materials in a more tacit, prosthetic approach. It also concentrates on the epistemic potential of such materials for interdisciplinary collaborations in unpredictable, serendipitous research. Three interdisciplinary case studies were

conducted with contributors from various creative fields, industry, and science. This approach highlights the nature of tacit working practices in relation to their potential for holistic experimentation, as discussed by Ingold (2010). InBetween reveals the dose of serendipity needed for emerging material technologies and research. The project combines the alchemical "Wunderkammer" (Leibniz 1600; Munster 2006) with modern forms of collaborative investigation and the tool-making characteristic of science laboratories. This methodological hybrid reveals the element of wit and the unprejudiced exposure to working with different experts that both typify the research undertaken at the Constance Open Innovation Lab (OIL).

The natural sciences and engineering show how new material possibilities and technologies contribute to increasing efficiency and productivity. But these fields are often *inaccessible* and highly *specialized* (Hecht 2014). It goes without saying that the accessibility of "smart" materials will greatly influence their uptake and creative exploitation. Such materials boost the demand for new design explorations, techniques, knowledge, and applications. Materials that change in response to external stimuli, that have programmable properties, or that adapt to environmental conditions differ radically from conventional design materials. And yet these substances require hands-on experience to grasp their phenomenological and technological complexity. In this respect, it is both a matter of asking questions about the materials emerging from the technology sector, and of instigating the invention of new materials and fabrication techniques from design and from the creative sector in general. The present research speaks of *prosthetic materials* to describe a new, more embodied, and tacit approach to these materials, which resemble those found in *craft practices* (Coelho et al. 2007). The proposed mediatory, reciprocal capacity of prosthetic relations, which is also known as "agential capacity" (Barad 1998), "assemblage" (Latour 2005), "rhizomic structure" (Deleuze & Guattari 1987), or "relational agency" (Bennett 2007), seeks to enact the intentionality distributed between human and non-human actors, where the human is considered to be a part of a larger system that interacts in equal measure with the non-human, cultural, and socially grounded world. Prosthetic materials for designerly application require embodied understanding and creative intuition. This approach shifts the focus from performance and durability, characteristic of an engineering approach, to aesthetic qualities. The Inbetween research approaches prosthetics as a bodily, incorporated subset of apparatuses (Coté 2010) that highlights the relational possibilities between technology and embodiment in the essence of action. The epistemic, integrative, and mediatory capacity to approach prosthetic materials as an entirely embodied experience suggests ways of perceiving and understanding our relationships with other beings and with our environment. InBetween investigates the dynamic capacity of prosthetic materials as a means of enacting, revealing, and encountering our bodily, environmental, and cultural reality as an array of dynamic relationships between the human and non-human, organism and machine. In an area focused so strongly on technical solutions and on different forms of evidence-based design, the originality of this research lies first in connecting architecture, textile design, and interaction design and second in exploring the possibilities of prosthetic materials for expressing adaptive and responsive forms of future living.

2.0 Epistemic potential of embodiment

Ingenious materials research and emerging material technologies often spring from interdisciplinary commitment and experience — and from an element of serendipity. In 2015, the Global Research Council (GRC) announced its intention to provide "researchers with the flexibility and intellectual space needed for serendipity" (GRC 2015: 2). It called on global research leaders to promote interdisciplinary or cross-disciplinary exchanges, so as to stimulate the desired serendipity, and to "encourage risk-taking and tolerate failure in research activities" (GRC 2015, p. 2). Peter Strohschneider, president of the German Research Foundation in Bonn, said "Real innovations are those that come about unexpectedly, and this means we cannot actually plan for and organize them. In our strategies, we have to institutionalize something we cannot actually institutionalize" (*sciencemag*, accessed 22.05.2017).

Serendipity in interdisciplinary collaborations opens up a space beyond disciplinary confines. It allows researchers to step back from purely disciplinary methods and perspectives and to engage in a collaborative space of future possibilities. To illustrate the potential of serendipity in materials-driven research, three key concepts of interdisciplinary, collaborative research are presented below: 1) "epistemic things" (Rheinberger, 1992/97) from the history of biology and philosophy of science; 2) "epistemic actions" (Kirsh & Maglio, 1994) from the cognitive sciences; 3) the "enactive approach" (Varela, Thompson & Rosch 1991) from neurophenomenology.

2.1 "Epistemic things"

The concept of "epistemic things" was first introduced by Rheinberger (1992/97). It was further explored as "epistemic objects" by Knorr-Cetina (1999) in biological and sociological contexts to describe the immediate, unfolding qualities of material realizations. These can range from figurative, mathematical "things" to all sorts of different things (Knorr-Cetina 2001), which "produce knowledge that we do not yet have" (Rheinberger, 1997, p. 28). Rheinberger describes such things as "Phenomenon and instrument, object and experience, concept and method [that] are all engaged in a running process of mutual instruction" (2010, p. xiii). The interactive, reciprocal activity of objects (e.g, test tubes and microscopes) with matter, organism with machine so to speak, is understood here as bound together in mutual specification and selection, which are both initiated and shaped by the environment.

2.2 "Epistemic actions"

Going one step further, Kirsch and Maglio distinguished "pragmatic action" (i.e., actual and pure task performance) from "epistemic action." They characterized the latter as "actions performed to uncover information that is hidden or hard to compute mentally" (1994, p. 513). Therefore an "epistemic action" is an active bodily engagement in a cognitive problem-solving task, where tangible objects and physical arrangements are used to perform this mental task. These notions of embodied, corporeal engagement and "epistemic action" question Kantian (i.e., Western) aesthetics, which privilege mind over body (and by implication over bodily engagements). Debates in contemporary design research on the credibility of practice-based versus practice-led research might fall into the same category. Instead of falling back into the Cartesian mind/body dualism between cognition, performance, and computation, it might be more theoretically useful to heed the idea that we are fundamentally in the world, embedded and embodied, and equipped with a perceptual and cognitive repertoire that makes no hard and fast distinctions between the inner and outer realms. Debilitating dualisms might exclude characteristic associations unintelligible to one another (Brandom 1994) and might tend to "fall within the domain belonging to the subject, mind and culture" (Bryant, 2011, p. 15).

2.3 "Enactive approach"

The "enactive approach" (Varela, Thompson & Rosch 1991) formulates a new mode of epistemic access. It does so not as a mode that represents a world, but as active, embodied engagement with the world. It thus suggests how we can understand our relationships with other beings, and with the environment, in a broader sense. The embodied-mind hypothesis refers to the "enactive approach" as the emergence of cognition, perception, and action as combined within the material, relational system, which includes body and world. Gallese (2000, p. 34) argued that the capacity for understanding others as intentional agents is deeply grounded "in the relational nature of action," and also in the interaction with the material world, so as to develop intentions and to construct beliefs. Empathy with others, and thus the capacity to recognize knowledge and memory as social and relational in nature, relies on understanding movement as intentional action (Küchler 2012). Dourish (2004, pp. 125–126) claimed that "We find the world meaningful primarily with respect to the ways in which we act within it [in ...] the creation, manipulation, and sharing of meaning through engaged interaction with artifacts." Consequently, embodied and active engagement enables us not only to activate social responses in interdisciplinary collaborations beyond disciplinary confines, but also to interact empathically and in a socially meaningful way in the world. The challenges for future research in this area — especially regarding the

responsibility for the complexity, interrelatedness, and relationality involved — are either to contribute or to increase the sensitivity to and the sensibility for new engagements with the world. This will make researchers better able to deal with social interaction (Peres 2011) and to extend communication and knowledge production to visual, tangible, and performative experiences between cognition and perception. New engagements with digital machines and prosthetic materials take into account crucial factors (body, sensation, movement, and place), and thereby subvert the classical emphasis on precision, order, and clarity of form.

2.4 Aesthetics and "form-giving" experiments

"Form-giving" (Klee 1964) focuses on embodied experiences and ideas that come into existence through – rather than are excluded from – an aesthetic engagement with emerging material technologies and research. This process builds on the experimental, emergent, designerly, and revelatory capacity of material experimental processes. This novel framework shifts the focus from performance and durability (typical of an engineering approach) to an emphasis on aesthetic qualities such as vividness or ephemerality.

An aesthetic perspective on prosthetic materials means to approach such materials not just for the sake of their potential technological efficiency and productivity, but where technologies come to pass, as felt in material, aesthetic experience. In the mid-1990s, Felix Guattari argued that technology could not be understood without locating it within the ensemble of its social relations (1995, p. 36). The current (and ongoing) redefinition and repositioning of aesthetics, understood as the active ensemble of cognition and perception in an "enactive" engagement, was also framed by Rancière's (2004) concept of the distribution of the sensible as an "aesthetic politics" of experience, which Bourriaud (2002) defined as "relational aesthetics." Exploring the material, sensual, and phenomenal dimensions of human and non-human interactions, the InBetween project examines certain boundaries and new perspectives on relational agency. It does so to propose that human interactions with prosthetic materials reveal empathy and enact socio-cultural relations and sustainable actions in the world. In such an account, cognition and perception are distributed within the "form-giving" process of movement, which causes the body to act within the world.

Together, "form-giving" (Klee 1964), the "elementary analysis of creativity," and Ingold's research (2010) capture the shift in focus from any final objectedness to form-giving — with a view to initiating motion and movement. Embodiment as form-giving is seen as a perpetual becoming and as a constant interaction with the environment. Also taking their cue from Klee, philosophers Gilles Deleuze and Félix Guattari argued that the essential relationship in the life-world is neither that between matter and form, nor that between substance and attributes, but that between materials and forces (Deleuze & Guattari 2004, p. 377). Pallasmaa (2009, p. 143) described how "In any creative field the process of unlearning is just as important as learning, forgetting as important as remembering, uncertainty as important as certainty." This uncertainty, which is experienced as an existential, menacing process of shaping and reaching across boundaries, is necessary to extend and suspend thresholds and to situate transit zones of material force-relations and spaces of affective engagement (Deleuze 1988). This hybrid research therefore involves a grappling with materials, an alchemical uncertainty about outcomes, and the scientific rigour of the modern material laboratory as an ideal setting for embodied learning, experimentation, and experiential developments in the field of emerging materials research and technologies.

3.0 InBetween collaborations: the "Wunderkammer" approach

Imagining "the world as a huge kitchen, well stocked with ingredients of all sorts" (Ingold 2010, p. 8), creative, intuitive InBetween research blended these ingredients and combined them in processes of transformation. Seeing the world full of substances and phenomena, the project entered a hybrid

research space situated between an alchemical “Wunderkammer” (Leibniz 1600; Munster 2006) and the scientific rigour of modern forms of collaborative investigations and the tool-making characteristic of state-of-the-art science laboratories. This hybrid constitutes the design tool proposed here.

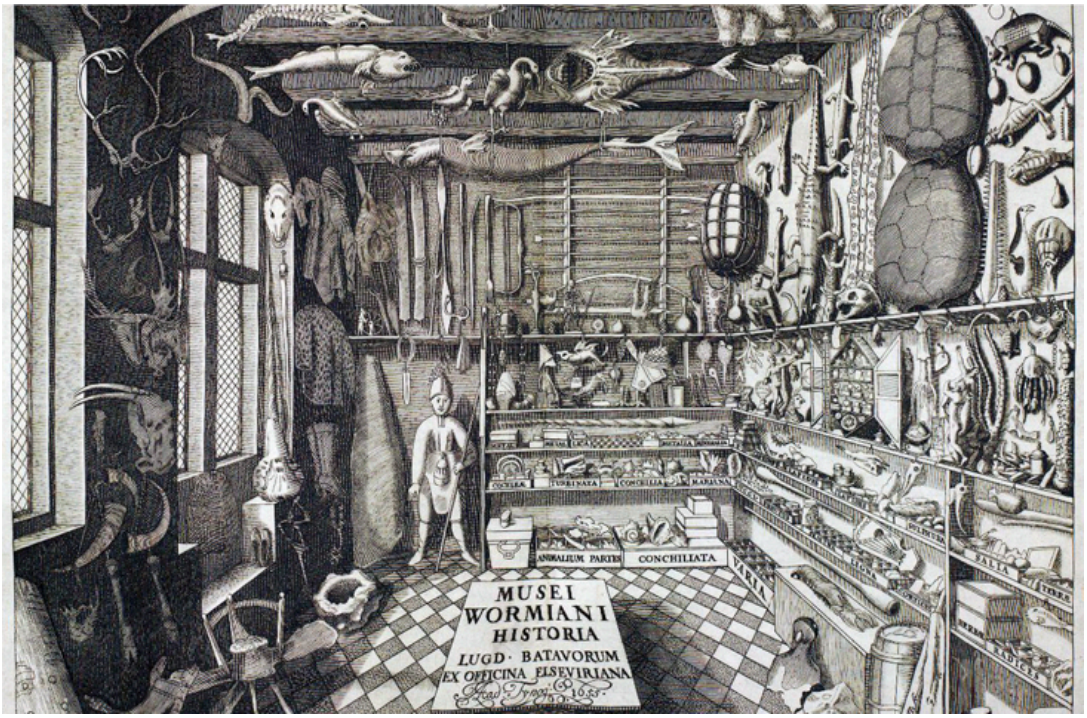

Figure 1. Copper engraving of a Wunderkammer, Museum Wormianum, 1655.
Source: https://en.wikipedia.org/wiki/Cabinet_of_curiosities

The sixteenth-century alchemist's “Wunderkammer” (curiosity cabinet or wonder cabinet) was an encyclopedic assembly of objects whose categorical borderlines still needed to be defined. At the time, objects carried economic, religious, magical, historical, aesthetic, or personal connotations, and knowledge was contained in the associative representation of things. Anna Munster (2006) described the baroque Wunderkammer as a “relation of spaces of matter, knowledge, memory and technics to each other” (2006, p. 6). She also understood it as the affective engagement with the natural and the artificial, and with their differential relations, which are situated between embodiment and (alchemical) techniques as pulsating force fields. This differential logic places body and machine, sensation and concept, nature and artifice in ongoing relations of discordance and concordance.

Such an approach enables researchers to develop an embodied understanding of materials and to create new forms of sensing and acting substances. The discovery of new experiential levels of invisible processes may allow for social interactions that make new material values accessible. Three Inbetween collaborations are discussed below. Each took place in a different expert setting and involved varied time frames. The paper concludes by considering the Wunderkammer approach as a design tool for interdisciplinary collaborations.

3.1 InBetween collaboration I

The first InBetween collaboration was “Wunderkammer for Arising Matter: Practice-led Laboratory for Curious Materials” (17–19 November 2016). This venture was run as a workshop-cum-micro-symposium

at the Department of Interaction Design, Zurich University of the Arts (the project received internal funding; its organisers and facilitators were L. Franzke, C. Winkler and V. Ziegler). Guest speakers, participants, and workshop contributors (from the creative disciplines, industry, and science) were invited to the hybrid event based on their extensive experience with novel materials. Work focused on "soft materials" and "bionic principles" through applying diverse instruments from science laboratories, self-developed tools, and a host of materials readily available in the experimental space. The first workshop served to evaluate the usefulness and the importance of the proposed "Wunderkammer" format as well as its creative outcomes.

Figure 1. Wunderkammer for Arising Matter
Source: C. Winkler

During the three-day "Wunderkammer" event, expert participants explored multiple perspectives on their experiences with materiality and differing practices. Results were displayed in a public "Wunderkammer"-style exhibition of material body-and-space experiments.

Figure 2. Wunderkammer Laboratory
Source: V. Ziegler

Figure 3. Laboratory working atmosphere
Source: V. Ziegler

Without participatory, real-world experimentation, novel material properties and technologies tend not to move out of the research laboratories in which they are developed. The InBetween pilot demonstrated the relevance and benefit of having materials readily to hand, both as constructing materials and as tools for embodied learning processes and inspiration. Applying prosthetic materials in enactive, form-giving experiments opened up new possibilities for producing responsive environments and for conceptualizing materiality more actively and more performatively. The research presented here intended to deepen understanding of such possibilities, to make explicit and to find the tools needed to develop new methods for experimental practice-based design research. Various experiments were conducted: with silicone and electroluminescent fluids (EL) and electroactive polymers (EAP); with silicone in combination with rigid materials like plywood, stones, and inflated air; with silicone, integrated threads, and inflated air; and with silicone and natural granulates, thermo-chromic colors, or shape-changing polymers. Our overall aim was to engage in and promote novel material exploration.

Figure 4. Fir cone growth principle
Source: V. Ziegler, A. Piñeyro

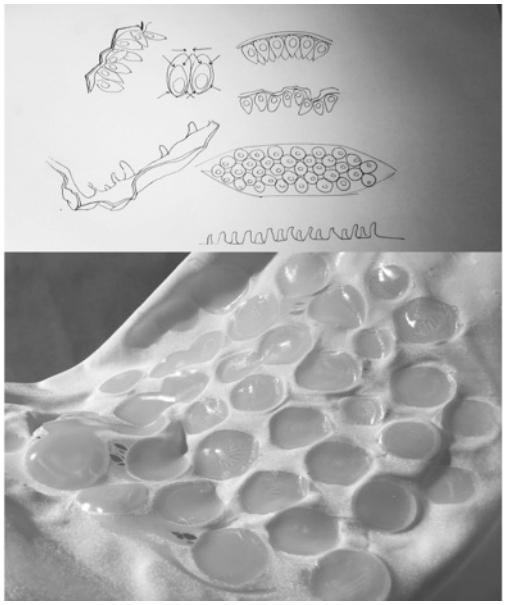

Figure 5. Skin membrane dehydration
Source: V. Ziegler, C. Winkler

The different outcomes (Figures 3–6) illustrate conceptual materializations of bionic principles and soft material properties. Figure 3 displays the interrogation of stretchable fabric, and silicone combined with plywood, in the search for self-bearing properties. Figure 4 shows the growth principle of a fir cone made of paper. Figure 5 illustrates skin membrane dehydration, which was conducted with stretchable fabric, silicone, and a heat gun. Figure 6 presents the surface property of a passion fruit, executed through fabric and ironed Polypropylene stripes.

In its thought-provoking, physical explorations, the first InBetween workshop offered practical examples of the new thinking about matter and about the materialization processes evident in contemporary theoretical debates, where researchers venture into the hypothetical and the unexplored as creators or catalysers continuously aiming for evolution in — and through — interaction. More generally, including socio-cultural processes in new materials research, technologies, and digital fabrication processes aims to produce a series of various prototypes for critical/speculative future living scenarios. These could result both in novel material exploration or indeed in the application of spatial wall elements or of course in artistic product development.

Figure 6. Passion fruit surface property
Source: Verena Ziegler, Ana Piñeyro

3.2 InBetween collaboration II

The second case study was conducted at the Open Innovation Lab (OIL). Based at Constance University of Applied Sciences for Technology and Economics (Germany), OIL is an interdisciplinary laboratory for digital fabrication methods and a hub for various faculties (Computer Science, Electrical and Information Engineering, Architecture and Design, Mechanical Engineering, Civil Engineering, Economics and Law). On the one hand, the laboratory embraces various key concepts ("Makerspaces," "Fablabs," and publicly accessible “Do-It-Yourself workshops,” where digital tools can be creatively developed, tested, and produced). On the other hand, it serves as an “innovation space” for collaborations with companies, where new ideas are invented, developed, and quickly brought to market maturity through rapid prototyping methods. Interdisciplinary cooperation among students, teaching staff, and researchers from all disciplines is key to the OIL. The main InBetween research was conducted within the OIL environment thanks to a Brigitte-Schlieben-Lange Research Grant for Excellent Junior Female Scientists and Artists with Children.

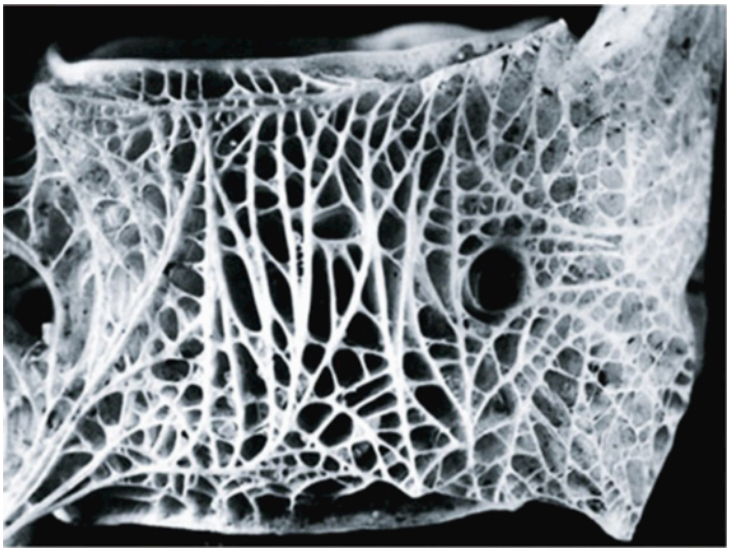

Figure 7. Microscopic picture of bone structure
Source: www.evolo.us/architecture/kmutt-learning-center-is-a-study-on-biomimicry/

The project call for this interdisciplinary collaboration was facilitated through the OIL environment and announced to mechanical engineers as a final undergraduate project toward earning a Bachelor's degree. The task was to develop a new lightweight construction material out of 3D filament disposals, analogously to the principles of bone growth and their highly mechanical load capacity (Fig. 7). Important aspects included the stated project goal, but also the capacity to accept failure (i.e., knowing neither what will happen during hands-on experimentation nor which material results to expect). The sustainability (i.e., reusability) of the filament disposals of digital fabrication techniques was a further aspect and a second stated project goal. The second case study rested on several main premises: to let the interplay between material forces takes its course; to avoid predicting the form of the material itself, but instead to allow form-giving processes to let unprejudiced material performance happen; to allow combinations with tracing, which at times constrained the hands-on techniques and embodied engagement.

Figure 8. First prototype experimenting with the growth principle of bone structures
Source: J. Dihrik, V. Ziegler

The resulting collaboration with Julien Dihrik, a mechanical engineering student, is an ongoing research project that is based on prototyping iterations to develop a filament-floss machine to create “bone” fabric. If successful, this fabric could be used for lightweight structures in the construction sector or in artistic product development, e.g., to create a series of marketable lamp clouds.

Involving active bodily engagement, initial hands-on experimentation with perforated cans, melted sugar, and a drill (Fig. 8) sought to discover how melted sugar on the fly coagulates to form a compound system. Sugar has a similar melting behaviour to the filaments used for 3D printing, e.g., PLA (Polyclactide) filament, which is based on biodegradable corn starch, sugar cane, tapioca roots, and potato starchon. The first experiments revealed that a consistent drilling mechanism and using a tight perforated container to retain and release the sugar are key to flying and compounding behaviour.

Figure 9. Second iteration – 3D printed ventilators to circulate candyfloss formation
Source: J. Dihrik, V. Ziegler

The second prototyping iteration refined the preliminary findings. 3D printed parts (e.g., a spinner head, fans to circulate the melted filament, and laser-cut fixed axes for the drilling machine) were constructed and tested within the OIL laboratory (Fig. 9). Further experiments and prototyping iterations will include tests with various filaments and their combinations, to detect if the flight characteristics and form assemblies will change during their material assemblages. Guided by creative intuition, researchers can mix these material characteristics as ingredients and combine them in transformation processes. The result of these two iterations is still unsatisfactory, but the adopted interdisciplinary working practice seeks to exemplify the mode of thought and action needed to situate transit zones of material force-relations and spaces within serendipitous research investigations.

3.3 InBetween collaboration III

The interest in mathematical minimal surface structures arose from the interest in biomimicry principles and in bionic principles found in nature. Key to minimal surface structures are their statically self-bearing properties. These use the minimum amount of material with the maximum amount of surface structure. Based on soap bubble experiments, minimal surface structures were tested to envision minimal surface principals (notabene without a professional mathematical background). The soap bubbles created, helped envision, but also served as material realizations of thought processes for

facilitating communication between different scientists and diverse visions of modular building structures. These soap bubble tests were translated into mathematical minimal surface formulas and, aided by a special mathematical programme ("Mathematica"), they were 3D digitalized and integrated into Rhino, a 3D design drawing programme, and subsequently translated into 3D printed minimal surface structures.

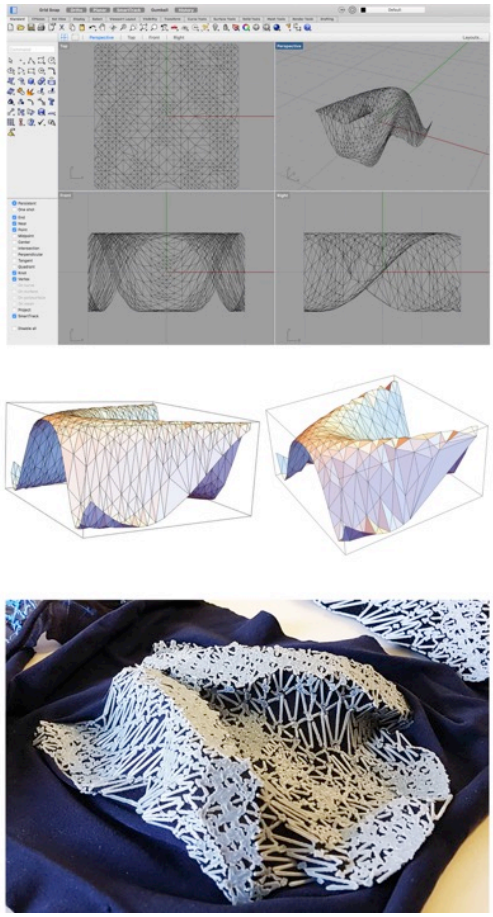

Figure 10. Mathematical minimal surface I
Source: V. Ziegler, S. Gerlach

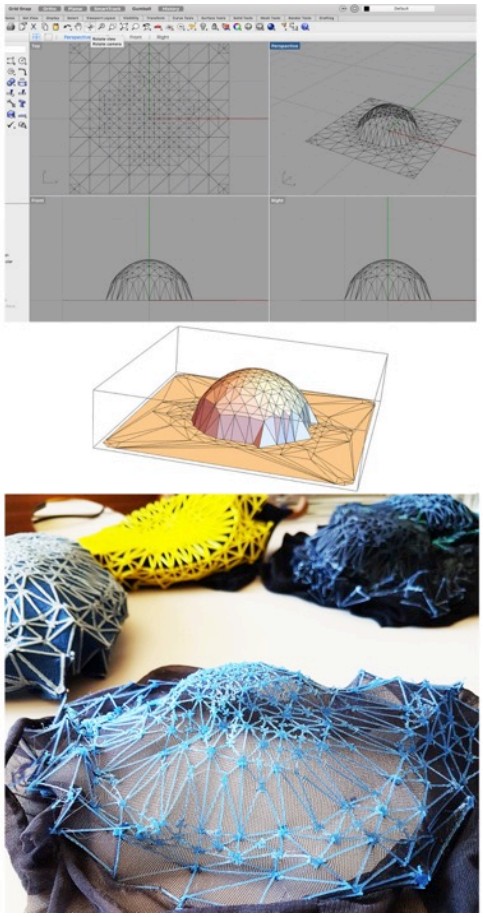

Figure 11. Mathematical minimal surface II
Source: V. Ziegler, S. Gerlach

The third interdisciplinary investigation is an ongoing collaboration with Stefan Gerlach, a lecturer in theoretical physics at the University of Constance. Further research will explore minimal surface structures, with a view to printing the lines forming the minimal surface onto stretched fabric. Collaboration is mainly via verbal communication, combined with images of bionic structures or 3D printed prototypes. These are subsequently translated into minimal surface formulas with mathematical principles of Delauny triangulations, in order to construct the lines out of the surface topology. This triangulated line topology is translated into Rhino onto a two-dimensional surface outline, which is then 3D printed on stretched fabric. After printing, the stretched fabric is released and the created compound system springs back into the minimal surface form. Shape-changing experiments with various elastic fabrics in combination with 3D printed PLA filaments have been designed to test the dynamic withstand value, which might increase with printed filament rigidity and, if so, create a textile filament compound

system. The idea is to create statically load-bearing lightweight structures by scaling digital fabrication techniques to a spatial format.

Conclusion

In a world focused on facts, statistics, and evidence-based technologies, intact communal, social, and cultural relationships – and assuming responsibility for the many pressing issues at large — seem to be disappearing increasingly. This paper has argued that the enactive "Wunderkammer – Lab" is a design tool suited to reconciling several persistent dualities: 'subject/object,' 'art/science,' 'making/observing,' 'mind/body,' 'aesthetic/rational.' This tool has the potential to shed light on problematic, yet deeply ingrained issues. As society moves progressively from discipline-based and siloed knowledge management toward non-linear models, our thinking needs to advance with our actions. Not only do we to interrelate and convey knowledge between different fields even more than at present, but we also need to free our minds through unpredictable, serendipitous collaborative research striving to reach beyond disciplinary confines. Such iterative, dynamic approaches reframe problematic situations and preferred states and bring into play both theoretical and practical approaches. The resulting, designed artifact can be seen as a method for opening up new space for design and other disciplines, where the artifact is recognized as a creative means of investigating what a potential future might look like. Fully recognizing the complex and entangled interdependencies within a globalized world, the InBetween project aims to foster linkages, knowledge exchange, and different perspectives through creating new materials and virtual alliances. Materials carry information into the social sphere, in which the material's inherent spatial quality helps to access, encounter, or grasp information in a tangible, bodily way by interrelating several layers of reality. In summary, this research:

- Promotes out-of-the-box perception through intersubjective approaches
- Fosters emotional awareness and alliances to understand material force relations
- Embodies knowledge rather than dissects knowledge
- Grasps interconnected layers and unveils different realities and streams of being
- Is aware of the impact and the consequences of human actions and involvement in social and collective values
- Understands material interfaces as performative media, which actively enact correspondences between the world's micro- and macro-levels

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References

Barad, K.: "Agential Realism: Feminist Interventions in Understanding Scientific Practices.", The Science Studies Reader, ed. Mario Biagioli, 1–11. New York: Routledge, 1998.

—: "Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter". Signs: Journal of Women and Society 28.3, 2003.

—: "Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning". Durham, N.C.: Duke University Press, 2007.

Bennett, J.: "Edible matter". New Left Review 45:133, 2007.

Brandom, R.: “Making It Explicit: Reasoning, Representing, and Discursive Commitment”, Harvard University Press, Cambridge, 1994.

Bourriaud, N.: “Relational Aesthetics”, Dijon: Presses du reel, 2002.

Bryant, L. R.: “The Democracy of Objects”. Open Humanities Press, 2011.

Coelho, M. and Maes, P.: “Responsive Materials in the Design of Adaptive Objects and Spaces”, 2007.

Coté, M.: “Technics and the human sensorium: Rethinking media theory through the body”. Theory & Event, 13(4), 2010.

Cross, N.: "Designerly Ways Of Knowing". Design Studies 3.4, 221-227, 1982.

Deleuze, G. and Guattari F.: “A Thousand Plateaus. Capitalism and Schizophrenia”. trans. by Massumi, B., Minneapolis: The University of Minnesota Press, 1987.

Deleuze G. and Guattari, F.: “A thousand plateaus”, trans. B. Massumi. London: Continuum, 2004.

Dourish, P.: “Where the Action Is”, First paperback edn, MIT Press, Cambridge, Massachusetts, 2004.

Elkins, J.: “What Painting Is: How to Think About Painting, Using the Language of Alchemy”. Routledge, London, 2000.

Gallese, V.: “The inner sense of action: agency and motor representations”. J. Consc. Stud. 7, 23–40, 2000.

Global Research Council (GCR) https://www.jsps.go.jp/english/e-grc/data/statement_principles.pdf.

Guattari, F.: “Chaosmosis: An Ethico Aesthetic Paradigm” Indiana UP, 135 pgs, 1995.

Haraway, D., J.: “Modest Witness@Second_Millenium.FemaleMan(C)_Meets_On coMouseTM: Feminism and Technoscience”, 287pp. New York and London: Routledge, ISBN 0-415 90386-6 (hbk), 0-415-90387-4, 1997.

Hecht, S. in: “Materials Experience: Fundamentals of Materials and Design”. Karana Elvin, Owain Pedgley and Valentina Ragnoli. Publisher: Elsevier, Editors: Elvin Karana, Owain Pedgley, Valentina Rognoli, 2014.

Ingold T.: “Bringing Things to Life: Creative Entanglements in a World of Materials”, 2010.

Klee, P.: “Notebooks Vol. 1: The Thinking Eye”. London, Lund Humphries Publishers, 1964.

Knorr-Cetina, K.: “Epistemic Cultures: How the Siences Make Knowledge. Havard University Press, Cambridge, Massachusetts, London, England, 1999.

—: “Culture in global knowledge societies: knowledge cultures and epistemic cultures”. Interdisciplinary Science Reviews, 2007, Vol. 32, No. 4, 2007.

Küchler, S.: “Social memory in the age of knowledge”, Blackwell Publishing Ltd. USA, 2012.

Latour, B.: “Reassembling the Social – An Introduction to Actor-Network-Theory”, Oxford University Press, 2005.

Latour, B.: “Reassembling The Social”. 1st ed. Oxford: Clarendon, 2005.

Malafouris, L.: "Before And Beyond Representation: Towards An Enactive Conception Of The Palaeolithic Image". 1st ed. 2017.

Malafouris, L.: “At the Potter's Wheel: An Argument for Material Agency”, 2007.

Massumi, B.: “Parables for the Virtual: Movement, Affect, Sensation”, Duke University Press, Durham, 2002.

MerleauPonty, M.: “The Structure of Behavior”, 1963.

Merleau-Ponty, M.: “The Structure Of Behaviour”. Pittsburg: Duquesne University Press, 2006.

Munster, A.: “Materializing New Media: Embodiment in Information Aesthetics”. Dartmouth College Press | University Press of New England, 2006.

Pallasmaa, J.: “The thinking hand: Existential and embodied wisdom in architecture. Chichester: John Wiley and Sons, 2009.

Peres, C.: “Sinnliche Erkenntnis-Experiment-Induktion: Zur Doppelfunktion der Ästhetik als Kunstphilosophie und ‚Logik der Erfahrung‘ bei Alexander Gottlieb Baumgarten, VIII“. Kongreß der Deutschen Gesellschaft für Ästhetik. http://www.dgae.de/downloads/Peres_SinnlicheErkenntnis.pdf

Rancière, J.: “The Politics of Aesthetics: The Distribution of the Sensible”, translated by Gabriel Rockhill, London: Continuum, 2004.

Rheinberger, H.-J.: “Toward a history of epistemic things: Synthesizing proteins in the test tube”. Stanford, California: Stanford Univ. Press, 1997.

—: “An Epistemology of the Concrete, Twentieth-Century Histories of Life”. Duke University Press, Durham & London, 2010.

Sciencemag http://www.sciencemag.org/news/2015/05/global-research-chiefs-seek-ways-foster-serendipity (accessed 22.05.2017).

Varela, F.J., Thompson, E., & Rosch, E. “The embodied mind”. Cambridge, Mass: MIT Press. 1991.

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