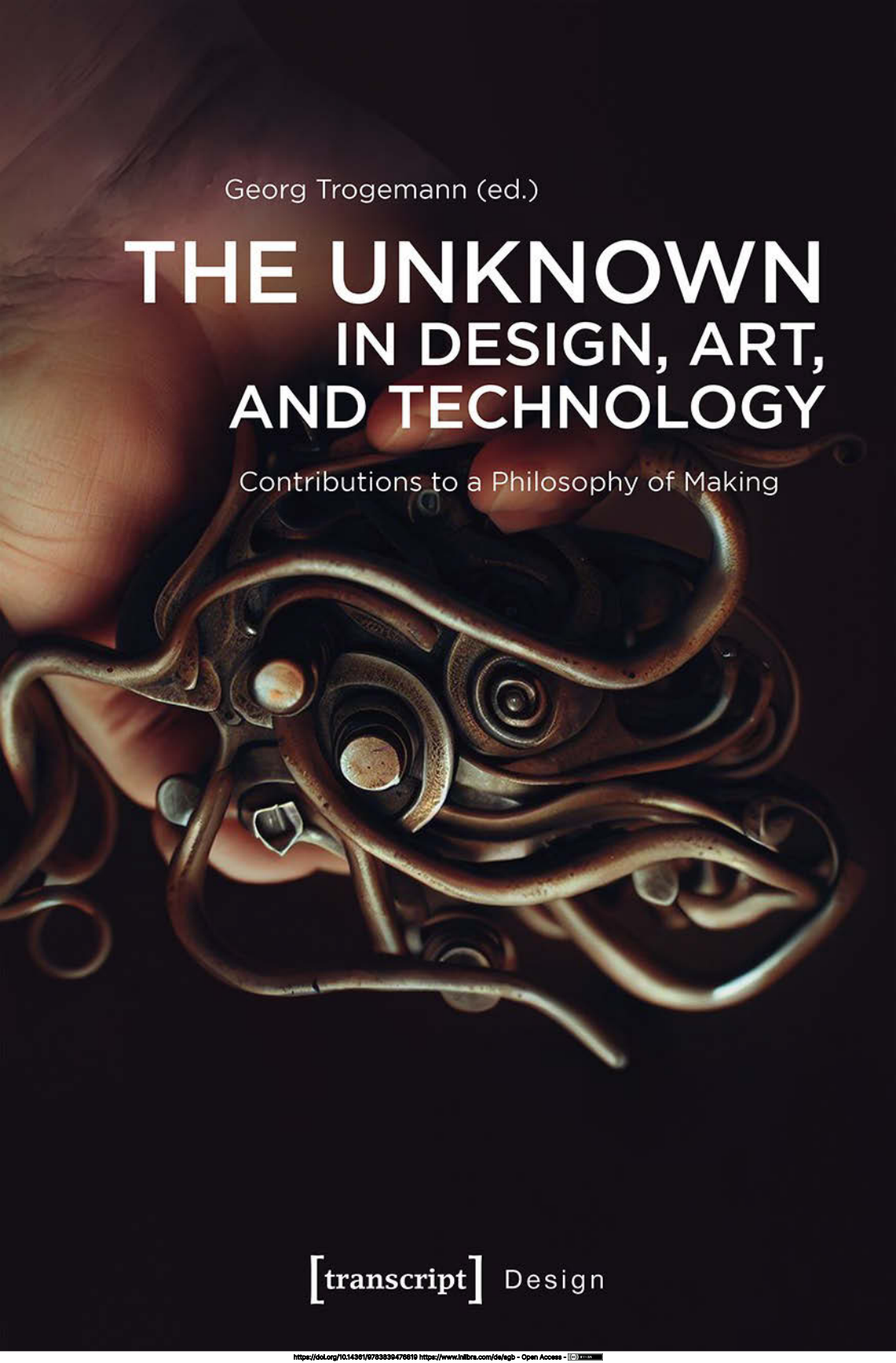

Georg Trogemann (ed.)
The Unknown in Design, Art, and Technology

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Contributions to a Philosophy of Making

[transcript]

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Carefully I test
My plan; it is
Big enough; it is
Unrealizable.
Bertolt Brecht [1]

Georg Trogemann

Introduction to the Unknown in Design, Art, and Technology **Contributions to a philosophy of making**

In 2021, the White Book on the future of design education presented an international overview of the situation and challenges of design in the 21st century.[2] Over a five-year period, a series of workshops and group discussions were held, and a total of 250 teachers, students and representatives of professional practice on four continents were surveyed in interviews and hearings. The result is a valuable overview of the current situation in design, which above all also highlights the heterogeneity and contradictory nature of the field. This is aptly summarized by one of the numerous bon mots highlighted by the layout: "Not even designers can agree among themselves on what design is."[3] Alternatively, as Ekkehart Baumgartner puts it in his essay: "Rarely has the use of a word exploded to such an extent: from strategy designer of all colors to the business designer, from influence designer to hair designer and nail designer. They are all designers – digital citizens are by dint of how they see themselves per se also creative citizens. The concept of design and that of the designer are, to resort to a human comparison, burnout patients in an A&E unit."[4] Design has long since ceased limiting itself to creating

1 Bertolt Brecht, "Sorgfältig prüf ich Meinen Plan; er ist Groß genug; er ist Unverwirklichbar.", (Translated by the author).
2 IF Design Foundation, Christoph Böninger, Fritz Frenkler, Susanne Schmidhuber, eds., Designing Design Education: Weißbuch zur Zukunft der Designlehre / Whitebook on the Future of Design Education (Stuttgart: avedition Verlag, 2021). The white book is also available for online download, accessed September 16, 2024, https://www.if-designfoundation.org/en/weissbuch-zur-zukunft-der-designlehre-als-pdf-zum-download/
3 Ibid. 80.
4 Ibid. 136.

meaning and style for tangible and visible products. Today, not only is everyone a designer, but professionals also deal extensively with abstract concepts such as processes, services and systems.
Moreover, major local differences also make it difficult to clearly define the field and draw uniform consequences for design teaching. At the African hearing in Johannesburg, the participants noted that design is often seen as an elitist, Western concept characterized by colonial influence. The aim must therefore be to break free from Western individualism and create an independent community-based design system rooted in traditional local contexts and oriented towards local and regional markets instead of having one's own resources and labor exploited in global markets. However, this requires developing a specific language for independent ideas and establishing a completely autonomous discourse. At the Asian hearing in Kyoto, discussions focused on the relationship between modern design and cultural heritage, such as the Kōgei practice. Although both modern design and Kōgei are holistic concepts reflecting political, economic, social, cultural and environmental concerns, Kōgei – like the arts and crafts movement – gains appeal by emphasizing the enduring value of everyday objects, countering the economics of short-lived trends. "Kōgei is appealing to designers because it serves as a projection area for the vision of social counterculture to anonymous mass production."[5] The role of beauty in design – which seems outdated from a Western perspective – was also discussed. Although beauty is fleeting and subjective, it is nevertheless associated with truth and economic success. Nonetheless, even speaking of a uniform Western or European perspective in this context seems problematic. For example, at the North American hearing in Pasadena, it was strongly emphasized that in the course of digitalization, design is increasingly determined by automated processes. Therefore, skills in algorithmic programming, artificial intelligence and machine learning seem to be "the literacy of the 21st century."[6] On the other hand, at the European hearing in Gmund, reservations were expressed about digitalization, primarily directed against the dynamism and social impact of these technologies. It was lamented that new facts are constantly being created and there is no time to

5 Ibid. 181.
6 Ibid. 256.

culturally come to terms with them and reflect more deeply on their consequences. Indeed, we know even less about what would have emerged if the Chinese, southwestern Asia, etc., perspectives on the current issues in the design had also been taken into account.

A general consensus and starting point for the White Book project on the future of design education was "that the status quo in design education does not suffice to overcome the challenges that result from the dynamic changes in technology, business and society."[7] Due to the changing economic conditions and other external factors – such as digitalization and globalization – under which designers work today, an urgent need for action in design education is unanimously identified. However, the need for change in design education is also due in no small part to the expanded importance that the design community ascribes to itself. Not only are the changing demands of design practice pulling the field in certain directions, but designers themselves – at least those who participated in the White Book project – are at the same time trying to push their profession into a central position in society, or rather trying to reposition it there. Throughout the history of design, designers have repeatedly struggled for a prominent position as political actors who attempt to intervene in social conditions. For many years, we have been observing a situation in which the term design is booming but has simultaneously become completely meaningless, because everything has become design. Design's current struggle for significance and interpretative sovereignty over its own profession is perhaps best illustrated by the following two quotes: "… design will in coming decades be the leading discipline when it comes to the comprehensive renewal of coexistence on Earth."[8] "The designer is the CEO of the future."[9] In any case, the authors of the White Book are firmly convinced that the influence of design will continue to increase over the 21st century, not least due to social ambitions and the preoccupation with ecological issues. In general, we are observing an increasing positioning of design as a solution-generating method for complex social problems, which comes surprisingly close to the current "solutionism" as the ideal of technological problem-solving approaches. With their business ideas, the New Tech Elite also claims to disrupt the economy and solve humanity's problems.

7 Ibid. 20.
8 Ibid. 141.
9 Ibid. 159.

The postulated central social role of design goes hand in hand with its future-oriented nature and a dedicated value-oriented approach. "The future is a constant theme in design. Design is geared to designing the future."[10] Design – like technology – has always aimed to improve the status quo. Its starting point is a self-critical reflection on the present and speculating about what responsible action for a promising future might look like. In this context, design is understood as a value-based practice through which cultural values are materialized, which is associated with a strong degree of social responsibility. "Since, over the last 150 years, design has been part of the developments in modern industrial societies that have brought us to our present-day situation (environment, digitization, politics, business, society), it should be considered an important social responsibility when it comes to managing the resulting tasks. In order to do justice to the discipline, the execution of design practice requires a framework of ethical-moral values that are bound by the common good. Design is a human-oriented and politically impacting practice."[11] Alternatively, as it was put in the African hearing: "The highest ethical aspirations are applied to one's own work. The question »What do you do?« should be answered with an entirely clear conscience: »I am a designer and I'm saving the planet.« The fact that there is no simple formula for saving the planet goes without saying."[12] The demand for an ethics of design culminates in a comparison with the Hippocratic oath. "Those who swear it commit to preserving life. Designers should take on a similar responsibility."[13] Of course, there are also other positions in design demanding that design must be amoral to fulfill its function. "The claim for ethics as a major criterion in design seems to be off the point, a symptom of immaturity. Ethics should be kept implicit in the process by using the appropriate methodical tools and communicative styles. We need a moral disarmament of design in order to become acceptable to other disciplines."[14] Wolfgang Jonas replaces the moral claim in design with the concept of responsibility. "Design is responsible for what it is doing. Responsibility is only possible if we do not retreat to

10 Ibid. 17.
11 Ibid. 254.
12 Ibid. 224.
13 Ibid.
14 Cf. Wolfgang Jonas, On the Foundations of a 'Science of the Artificial,' Useful and Critical – the Position of Research in Design, International Conference, University of Art and Design Helsinki, 1999, accessed September 18, 2024, http://8149.website.snafu.de/wordpress/wp-content/uploads/2011/07/1999_HEL.pdf

moral positions."[15] However, the assumption of responsibility presupposes that one is as clear as possible about the impact and side effects of one's actions. The fact that foresight is only possible to a limited extent in most cases restricts the scope for control. Moreover, the question of responsibility becomes all the more difficult as we transfer increasingly more decisions to automated technical systems.

The current situation in the field of design as summarized in the White Book is reminiscent of Bertolt Brecht's poem: "Carefully I test my plan; it is big enough; it is unrealizable." This overburdening of design is an unavoidable consequence of its self-positioning in the center of society, i.e. its commitment to responsibility for all forms of creation – not to say for the whole world – and the ethical and normative principles accompanying it. Put bluntly, without having any problem-specific knowledge itself, design aims to solve the major problems of our time. In this image, design sees itself as a cross-sectional or even anti-disciplinary competence that permeates and enriches other areas but has no autonomous substance. That is why much of what is formulated as requirements for a contemporary design education reads like the specifications for meeting the challenges that modern life presents to all of us. Everyone – not only designers – must acquire the skills required to a certain degree if they want to cope with today's life.

The broad consensus in the study on several statements considered essential to design is largely due to this postulated broader scope of the role of design in society. Thus, many shared convictions and the resulting demands on teaching have not emerged despite all of the different visions in design but they are precisely a natural consequence of the expanded scope. Some loose core statements and demands for contemporary design education from the White Book are summarized below into four main topics that hold particular importance for our approach:[16]

The thinking hand: In his article, Ekkehart Baumgartner places the thinking hand at the center of design practice, as a term that he borrows from Horst Bredekamp and his studies on Galileo.[17] He is convinced that the interplay of manual and intellectual considerations is the fundamental mechanism, and the concept of thinking with

15 Ibid.
16 IF Design Foundation, Christoph Böninger, Fritz Frenkler, Susanne Schmidhuber, 253-257.
17 Ibid. 133-143.

one's hands is also regarded as the central form of design research. Visual drafting was already used as an analytical and creative cognitive instrument since the Renaissance. However, the development of a holistic approach that combines intellectual thinking and manual action primarily requires a basic mental attitude that regards both areas as inseparable, as a kind of interlinked, joint movement. Moreover, not only professional designers but even children learn by acting and thinking about what they do. This underlines that design as a unity of thought and action is a fundamental human way of engaging with the world. If you ask about its foundations, you inevitably come to poiesis, which is already theorized in the philosophical concepts of Aristotle. The poietic roots of design are also visible in the following quote: "If we connect the conceptual duo of the Thinking Hand with the activity of the designer then the radical intellectual effort innate in the creative process essentially consists of generating actions or results that were not previously conceivable and that liberate humans from their determinacy and help improve the conditions of human life, but also have an enlightening impact."[18] However, the thinking hand needs an update to be effective in today's circumstances. The drawing pen – still a powerful tool – has been accompanied by other, often more abstract but sometimes also more powerful tools.

Digitalization and tools: The digitalization of recent decades has led to significant changes in all areas of life and had a major impact on design. Designers are claiming the role of developing the products and solutions of tomorrow in an increasingly technological and digital world. This raises the question of the level to which designers need to understand the digital technology they use. Where is the skillful use of the tool sufficient and where is a deep understanding of the underlying digital structures and algorithms necessary? The extent to which the underlying digital structures and algorithms must be penetrated depends not least on the task to be solved. The new software tools and especially artificial intelligence (AI) – which has become increasingly important in recent years – require designers to constantly adapt their processes to the new possibilities of the tools to achieve better or at least faster results. In terms of purpose, tools are neither good nor evil, and naturally

18 Ibid. 139f.

they can be used for constructive as well as destructive objectives. At the same time, tools are never neutral: they have an enormous influence on the direction in which the design process – whether material or social – develops and what result is ultimately achieved, or which phenomenon ultimately manifests itself. In this context, it is insufficient to know the rough horizon of a new technology, as designers must become active participants in the experimental space of AI and digital technologies. Design can only retain its claimed autonomous position if it is also actively involved in the development and experimental exploration of new digital tools. Design has not yet taken a convincing position on this issue, which is particularly important as the aesthetic possibilities are also a consequence of the tools used. At the moment, it seems that aesthetic decisions come at the end of the design process, after many different and sometimes conflicting interests of different interest groups have been taken into account. This practice is based on an oversimplified understanding of aesthetics.

Teamwork and interdisciplinarity: Design within the framework of the thinking hand is also understood as a cultural experimental space in which different interests and players can come together. Design must constantly respond to changing circumstances and contemporary challenges. Successful methods from the past might prove inadequate in future projects. In order to do sufficient justice to most of the tasks facing us today, the skills of designers must be combined with those of engineers and stakeholders from many other fields, whereby the boundaries are inevitably blurred. This diversity of participants is seen as an enriching success factor. Design is regarded as a post-heroic practice that is not dominated by individual geniuses but primarily thrives based on the cooperation of mixed teams. Interdisciplinarity is considered important but at the same time contemporary design claims a special role within the network of diverse competencies. Within organizations, design is not seen as limited to one area but rather fulfills an overarching function that connects all areas. Designers are playing the role of moderating the controversies of different stakeholders and integrating different expert views into holistic perspectives, such as in value sensitive design (VSD). To fulfill this function, the ability to communicate in international, intercultural, interdisciplinary and cross-hierarchical constellations is considered indispensable. Therefore, sensitivity to

cultural contexts and traditions is considered an important qualification in design practice.

Uncertainties and ignorance: Dealing with uncertainty is typical for design. Solving problems and achieving goals under uncertainty requires domain-specific experience, intuition, and the ability to improvise. Modernity believed in predictability, plannability, and controllability, and our Western society remains dominated by the conviction that our world – including its future – can be entirely understood from a single perspective, consistently described in language, and entirely controlled through our actions. However, we no longer trust the popular slogan of the tech sciences: "The best way to predict the future is to create it."[19] Political, economic and social developments are just as unpredictable as the effects that our technologies have on us. Of course, we have to design our technologies and products responsibly with the intention to create a future worth living. Within a definable framework and for detailed questions, it is often not only possible to make very precise predictions but also important and desirable technical improvements. This striving for improvement is at the heart of technical development and design, although this does not tell us anything about how our lives will feel in the future. This scientific view that the world is completely controllable – in the short circuit of prediction and active design – should be overcome. However, seeing the world and our poietic actions within it differently remains a challenge for everyone who tries to create something today, including designers. In the currently prevailing scientific worldview, ignorance is still primarily seen as a deficit, as not yet knowing. However, there are also forms of not-knowing, such as not wanting to know, not being able to know in principle, or consciously forgetting to make a new beginning possible, all of which are not only important for mastering everyday life but also for creative processes.

In this publication, we proceed from the assumption that there cannot be a complete and coherent theory of design; rather, we assume that design itself is a fundamental human activity that needs an ontological rather than theoretical positioning. The basic form of this activity is captured in the term poiesis, which is

19 A saying originally associated with Abraham Lincoln. However, in the digital world, reference is usually made to Alan Kay: "The best way to predict the future is to invent it".

derived from the ancient Greek ποιεῖν and simply means "to make." Aristotle divided reason into three basic forms: practical, theoretical and poietic episteme. Theoretical reason analyses what is given, practical reason designs the rules of our behavior, and poietic reason is techne (art, skill, craft, and technique), an action aimed at production guided by appropriate planning. Poiesis thus asks about the forms of thinking, planning and acting that become active when a person designs and produces something: an object, a poem, a process, a machine, etc., which was not there before and which – as soon as it is brought into being – separates itself from its creator and becomes effective in the world. Aristotle's generic term for such a production is "techne." According to Georg Picht,[20] the theory of poiesis intended by Aristotle but never fully developed should have included everything that the Greeks called techne: all crafts, medicine, all arts, but also large areas of politics and economics. It would thus have been a theory of all possible forms of production, and it would have been a philosophy rather than a scientific theory.

This is where design comes into play. "Anyone who wants to do something must have an inner vision of what is to be done. Making is always the execution of a model, and the models that are executed are what we call drafts in everyday language. The primary content of the draft would therefore be the image, model or scheme of an inner vision."[21] Our modern understanding of design begins where preparatory and anticipatory activities are becoming increasingly important: activities that are no longer directly aimed at manufacturing a product or other artifact but instead comprise creating a draft. With design, poietic action becomes "action at a distance."[22] Thinking and acting become separated, although they are still related to each other. This temporal and methodological separation of thought and action underlying design is very crucial and powerful but also the source of many fundamental problems that design has to struggle with, especially today. Even though designing is also an action, it is no longer an action on the final artifact, but rather a symbolic, abstracted and model-based substitute

20 Cf. Georg Picht, *Die Kunst des Denkens, in: idem, Wahrheit, Vernunft, Verantwortung, Philosophische Studien,* (Stuttgart: Klett-Cotta, 1969), 427-434, (Translated by the author).
21 Ibid.
22 Cf. Robin Evans, *The Projective Cast. Architecture and its Three Geometries,* (Cambridge Mass.: MIT Press, 1995).

action. Models, sketches, technical drawings, notation systems and other semiotic practices take on a representative role, with the help of which the final properties of the product – whatever it may be – are gradually developed. The properties are anticipated by means of semiotic representations and thus made available for communication, the generation of variations and for evaluations. The practical basis of design lies in these semiotic renderings and the associated tools, operations, methods and distributed processes. With the advent of digitalization, this practical basis has fundamentally changed and continues to reflect a major challenge for the coming decades.

It is interesting to note that up to this point we still have not made a clear distinction between technology and design. Both make massive use of semiotic tools, and both are only successful if they fit properly into the global context in which their products become effective. The separation of technology and design is only possible if – as is common in the Western tradition – we forcibly divide our human productive imagination into rationality and intuition (or technical functioning versus sensation, meaning, and aesthetics) and let the two compete against each other. Only with this artificial division of a holistic human ability – a division that is due more to our striving for specialization than the matter itself – can one profession deal with functionality and the other with its aesthetics. In the course of this division of labor, the overall responsibility for the negative consequences of poietic activity is also lost. Taking back responsibility for our poietic actions primarily means seriously reconsidering the structures within which we operate, as we shape our living conditions with ever more powerful technologies, but under increasingly precarious conditions for the planet and our nature. Although the poietic system that we have implemented has been very successful in the past and led to material prosperity in large parts of the world, not only are the limits of the narrow disciplinary perspectives becoming increasingly apparent but the destructive powers of this system are now also clearly visible. It is obvious that our poietic reasoning urgently needs an update. The renewal that guided this publication is based on the ontology of the British philosopher Andrew Pickering:

> *… the first step is to characterize what I think of as humanity's usual pattern of acting in the world. This is a stance of dualist domination. We humans tend to act as if we are special, the lords of creation, transforming what we like to think of as a docile world to suit our own ends. This is the stance that Martin Heidegger (1977) called enframing – treating the world as a "standing reserve" – which has got us into so much trouble, and which we can think of as acting on the world. And then this other stance that I want to explore, this other pattern of acting, would have to acknowledge instead that we live in fact in a lively world that we cannot control and that we therefore have to learn to get along with. This is the stance that Heidegger called poiesis, which we can think of as acting with the world rather than on it.*[23]

This is a much more modest approach than the one formulated in today's design. We do not claim to solve the big problems of our time. At the same time, it is a challenging project because we need to develop new perspectives on the functions of knowledge, experience, and aesthetics as well as their interplay. Our concern focuses on the search for a new relationship between design, technology, and scientific knowledge, a relationship that allows us to take responsibility for our present-day poietic actions. No theory of poiesis that has this as its goal can be completely absorbed by science, nor can it be a purely technical or aesthetic practice. The four major themes from above (the thinking hand, digitalization and tools, teamwork and interdisciplinarity, uncertainties and ignorance) are still central in this perspective, although they now have a different coloring. Ultimately, this is still a sufficiently large project to be unrealizable in Brecht's sense, at least in the short term.

One of the central demands of our approach is that "the 'knowledge base position' needs to be complemented by the 'unknowledge base position' or by the competencies to deal with not-knowing," as Wolfgang Jonas is cited in the article by Zahra Ganjee.[24] As already mentioned, in traditional sciences, not-knowing is usually equated with not yet knowing, as a gap that needs to be closed. Nonetheless, the classical sciences have also always struggled with various forms of fundamental unknowability. Everything we know about the past – for example – must either be remembered, have been recorded in media, or have left other visible or at least measurable traces in

23 Andrew Pickering, "Acting with the World: Doing without Science," e-cadernos CES [Online], 38 | 2022, Online since 31 March 2023, connection on April 02, 2023, http://journals.openedition.org/eces/7894

24 Wolfgang Jonas, Design Research and its Meaning to the Methodological Development of the Discipline, in: Ralf Michel, Design research now, (Basel: Birkhäuser Verlag, 2007), 187-206, 202. See also the article by Zahra Ganjee in this book.

the present. If something has left no material marks of any kind, not even a trace in a person's memory, it simply did not take place. Indeed, traces are rarely unambiguous: they usually allow for different interpretations. Likewise, we have no access to events that may be taking place at this very moment but in places that are not accessible to us with our own senses or the technical extensions available today.

However, there are other forms of not-knowing that are not related to gaps in scientific knowledge but rather to strategies for dealing with what is known at an individual or social level. Conscious concealment and hiding (for personal or communal benefit), deliberate ignorance (to free oneself for a new beginning, to eliminate prejudices), not wanting to know (to simplify and narrow), not being allowed to know (for security or ideological reasons) are all variants of ignorance that also play an important role in connection with the production of artifacts and in poietic action. These interactions between knowledge and ignorance usually fulfill social and communicative functions and are very close to the concept of information, its transmission, distribution, provision, encryption, and – finally – its deletion. Knowledge here is something that has an external existence, something that can be traded, that one has and others do not have, or vice versa. Once transcribed, this knowledge can easily be exchanged between machines, allowing us to delegate increasingly more of the actual production to the machine and our networked technical milieu. What remains for the human being here is the planning of the making, i.e., the organization of the information necessary for production by machines. At the same time, this leads to the current situation, where "we live in complex societies with a high division of labor, in which all members are ignorant of almost all knowledge. Individuals know that their knowledge is limited. This contrasts with the fact that individuals benefit from knowledge that they do not know."[25] This form of knowledge processing today forms the foundation of the 'dualistic stance,' as Pickering calls it. Economically, it has been very successful in the past, but at the same time it has caused us enormous ecological problems and a drastic reduction in our self-determination. Therefore, today

25 Nico Stehr, Wissen und der Mythos vom Nichtwissen, in: Aus Politik und Zeitgeschichte, 63. Jahrgang, 18-20/2013, 48. (Translated by the author).

we find ourselves in the contradictory situation that science and technology are constantly increasing our ability to change our living conditions while at the same time the predictive control over their social consequences is decreasing. It is only the power of the techno-scientific system in its entirety that is growing, while the opposite is true for the individual. "Paradoxically, the ability of society as a whole to produce and operate complex technologies is constantly increasing while individuals are increasingly limited in their possibilities to produce something with their own hands, or even to secure their own survival."[26]

In contrast to these information-centered forms of knowing and not-knowing, there is this other form of fundamental unknowability that Andrew Pickering points to: the ontological fact that the future is neither controllable nor fully knowable. In a world in which we are largely unable to simulate and predict the future with the help of our semiotic processes, self-responsible human action regains its value. Nico Stehr's concept of knowledge comes very close to the requirements of Pickering's 'poietic stance': "Instead of defining knowledge as something that a person owns or can acquire relatively easily – an idea that applies more to the concept of information – the knowledge process and knowledge relations should rather be seen as an action, as something that a person does."[27] In this poiesis-based view, action and performance are more important than scientific knowledge. The poietic process is characterized by the fact that something unforeseen can happen at virtually any moment. Indeed, this moment of surprise is often the starting point for a new aesthetic search process. Put simply, one could say that the aesthetic experience is based on its unpredictability. In this picture, mistakes are not simply something that must be anticipated and eliminated, but something that is necessary to make progress. They are merely those actions that did not have the desired success, the divergence between intention and result. Only afterwards is one wiser. From this perspective, the cyclical nature of design processes is a natural consequence of our inability to fully foresee the consequences of our actions, often even the effects of smallest changes. Instead of control, it is about creating the frame conditions for phenomena to manifest themselves.

26 Georg Trogemann, Konstantin Butz, eds., *In the Making - An Investigation into Creation in Art, Design, Architecture and Technology,* (Cologne: Verlag der Kunsthochschule für Medien, 2022), 12.
27 Nico Stehr, Wissen und der Mythos vom Nichtwissen, 51.

However, the question of where the boundary between the foreseeable and the unforeseeable lies is undoubtedly a very tough nut to crack. An important question thereby is how far the area of prediction can be separated from the rest of the world. Only where it is possible to delimit the actors, their actions and interactions, as well as their effects, can prediction succeed, and even then there are still various epistemic obstacles to overcome. As long as we do not know the laws according to which the delimited areas develop, as well as their current state, and can also carry out the calculations necessary for a prediction quickly enough, no precise forecasts are possible. Mathematics – together with science and technology – has developed very powerful tools to make very precise predictions in a wide variety of fields. In this game, the unconsidered and undesirable aspects of the applied models find their place under the term 'side effects.' However, in most life-relevant situations, neither the network of actors nor their interdependence and sphere of influence can be fully determined. This is not a matter of a lack of information and a lack of predictability tools but real, ontological indeterminacy that cannot be avoided by any model. Here, in this infinite and inextricable entanglement with the world, all poietic projects have their origins, regardless of whether we attribute them to technology or design. Indeed, science becomes a problem when it claims responsibility even though it does not have the necessary skills and tools. Mathematics, science, and technology have joined forces to form a powerful troika for innovation and production. However, what we forget is the fundamental difference between creating and understanding: knowing and applying the actions necessary to produce something does not mean that we understand the effects that the artifacts have once they exist and are integrated into a living environment. The institutions of technology assessment – for example – have long since given up the idea of being able to predict the consequences of technology. Founded in the 1960s and 1970s, when the negative social and ecological effects of modern technologies became obvious, they have increasingly become an instrument for producing orientation knowledge for decision-making processes in politics, business, and society regarding the handling of upcoming technologies in recent decades. In this sense, we nowadays can produce far more than we understand and for which we can take responsibility.

One of the central questions in this context concerns what the thinking hand – in which doing and understanding were inextricably intertwined – can mean today. It becomes obvious that one of the basic characteristics of design – acting at a distance – is reaching its limits. This is also the core of Pickering's "poietic stance," which is based on an intimate reciprocal relationship that demands involvement and direct engagement with material processes and thus brings us closer again to nature. Sensual experience as well as thinking and reflection must remain united in the design process to achieve results that meet today's challenges, although developments in the digital field and AI in particular currently suggest the opposite. In the White Book, the example of image creation and processing is used to show how much the entire industry has changed as a result of digital technologies. All analogue image processing activities – which once mainly comprised manual operations and material processes – have been digitized, automated, and thus devalued as a service. "What remains then is merely to take a decision on nuances of taste, with judgment becoming the Kantian core competence of design."[28] This is not only a misunderstanding of the aesthetic challenges that new technologies pose to us today but also an illusion to believe that all design tasks can be solved by sitting down in panels to develop solutions at the green table, which can then be confidently left to the machines for implementation, or by using digital forecasting tools to decide on the future.

As already mentioned, we must also be aware that tools are never neutral, as if we are completely free to use them for both good and bad, as one often reads. However, in fact, our results are largely predetermined by our tools. It is unfortunately very common for the digital to be presented as something immovable and definitive that has come upon us like a natural phenomenon. Nonetheless, technologies are invented by humans and must be shaped and directed by them. AI – for example – is often either seen as a technology that merely filters patterns out of mountains of data or creates variants of the known, or – in the opposite – as a coming power that is about to take control. This is a fundamental misunderstanding of digitality and technology in general. It is neither

28 IF Design Foundation, Christoph Böninger, Fritz Frenkler, Susanne Schmidhuber, 30.

helpful nor does it solve the actual problems that digital technologies entail if they are positioned as an inferior counter-model to autonomous design. Anyone who wants to be effective and politically active in the digital sphere today cannot avoid engaging with the inner structure of technologies to such an extent that at least their horizon becomes visible and comprehensible. A deeper understanding of how algorithms and AI actually work is indispensable for this. Beyond this, in design, technology must be seen as an aesthetic field of experimentation of its own kind. The aesthetic potential of technology can only be exploited if we do not see virtual and augmented reality technologies or AI – for example – as completed developments but as open and exciting experimental fields for new aesthetics. Only through the direct and playful use of technology can new phenomena be discovered and stabilized in artistic laboratory experiments. Acquiring the technical and theoretical prerequisites for this is anything but easy, and it is insufficient to refer to interdisciplinary cooperation here; rather, a new transdisciplinary relationship must be created between technology and design, where the individual acquires the knowledge required for the specific problem across disciplines. At the same time, a critical attitude towards scientific knowledge and methodology is necessary, which does not always provide the solution but is often part of the problem.

With the book at hand, we bring together a series of essays highlighting individual ways of dealing with the unknown in various design situations. The 'poietic stance' outlined above – which has its roots in philosophy – forms the background for the very different points of departure in teaching, research, art, technology, everyday life, and even military policy. In contrast to scientific reflection, in which the material side of a topic is regarded as insignificant and pushed as far into the background as possible in favor of the conceptual side, we are striving for poietic reflection here. Although the scientific text refers to something outside itself, it claims to be conclusive and contain everything essential. It is based on logic and rationality and aims at secure knowledge that is repeatable and universal and can predict future events. On the other hand, poietic reflection is based on the inseparability of action and notion and refers to habitual knowledge and experience. It is aware that texts, i.e., linguistically formulated

reflection, cannot replace vibrant experience and our sensual being in the world. Since they are texts in a book, the articles presented here therefore necessarily contain only one side of the coin, namely the reflection of the absent other side. At the same time, language is a very powerful tool to depict the knowledge that arises when we reflect on our experiences and actions. These reflections do not have to be strictly rational and logical – as in purely scientific representations – but refer to research oriented towards action and embodiment, which only brings about the event that it reports through its own actions. This inevitably means that the contributions do not deal with current issues of industrial design processes but instead focus on experimental approaches to design challenges in academic environments. In this sense, the articles are to be seen more as contributions towards a yet-to-be-developed philosophy of making than as the presentation of building blocks for a design theory.

The first article is based on the observation that the current wave of generative AI tools is fundamentally reshaping the world of work in many industries, and consequently also changing the way in which designers work. In their contribution to this book, Steffen Mitschelen and Natalie Weinmann raise the question of how working with these new and yet unknown tools will transform the design discipline. The authors report on a workshop they have conducted with design students to address the question of which skills are necessary to navigate an uncertain future in which outcomes can increasingly be generated automatically. The article comprises two parts, each written by one of the authors. The first part reports on the workshop's setup and procedure, investigating the role of interpretation in dealing with the unexpected generated results by finding suitable applications for them. The second part explores how the students' experiences with unfamiliar tools and approaches are shaped by their knowledge, past experiences, and expectations, influencing their actions.

In her article, Zahra M. Ganjee discusses the complexity of design projects, highlighting ambiguity, uncertainty, and the impossibility of knowing all of the fields involved as key characteristics of complex problems. She argues that purely scientific research is unable to fully recognize the implications of acting in a space of uncertainty. Therefore, as already mentioned above, the 'knowledge base position'

should be complemented by an 'unknowledge base position.' In this context, primary generators in design (references and precedents) become important. Therefore, by comparing the two, she attempts to clarify the relationship between the use of references and the notion of not-knowing in the design process. In other words, the article discusses how the design process can commence from a state of not-knowing. It also addresses three existing approaches to facilitate complexity and interact with uncertainty in design: the transformation designer's co-evolutionary approach, Andrew Pickering's doing-without-science approach, and Donald Schön's interactive approach. Each one of their methods assists designers in dealing with ambiguity, unpredictability, and unknowns in complex situations.

Christian Rust's study explores the process of creating a violin bow through an autoethnographic approach. He aims to unravel the unknowns surrounding the question of what it is like to engage in this form of craftwork through the only route considered viable. The reflection upon the experiences and findings in this process leads to the proposition of a framework for research into artifacts centered around the three interconnected and interdependent key elements of skill, experience and knowledge. While the focus in this article is placed on experimental creation, it is believed that the threefold framework can be applied broadly to other forms of artifactual research.

The article by Somayyeh Shahhoseiny addresses one of the challenges in designing dwelling places for migrants in host societies. Populations forced to migrate as a result of war, natural disasters, or economic and political pressures often lose their ability to 'dwell,' exercise agency, and form a sense of identity in the host country due to unfamiliarity with the new situation. Her article defines the home as an objective and tangible extension of the self (body) and even a symbol of the self. To address this issue, she utilizes the concept of forgetting as a form of not-knowing, which plays a crucial role in alleviating the fear of the unknown and serves as a path toward dwelling in a new environment. Here, moments of forgetting are referred to as moments of insight.

In his research project, Tobias Bieseke investigates the interplay of narration and interaction in extended realities. He is particularly interested in the individual experience of participants when confronted

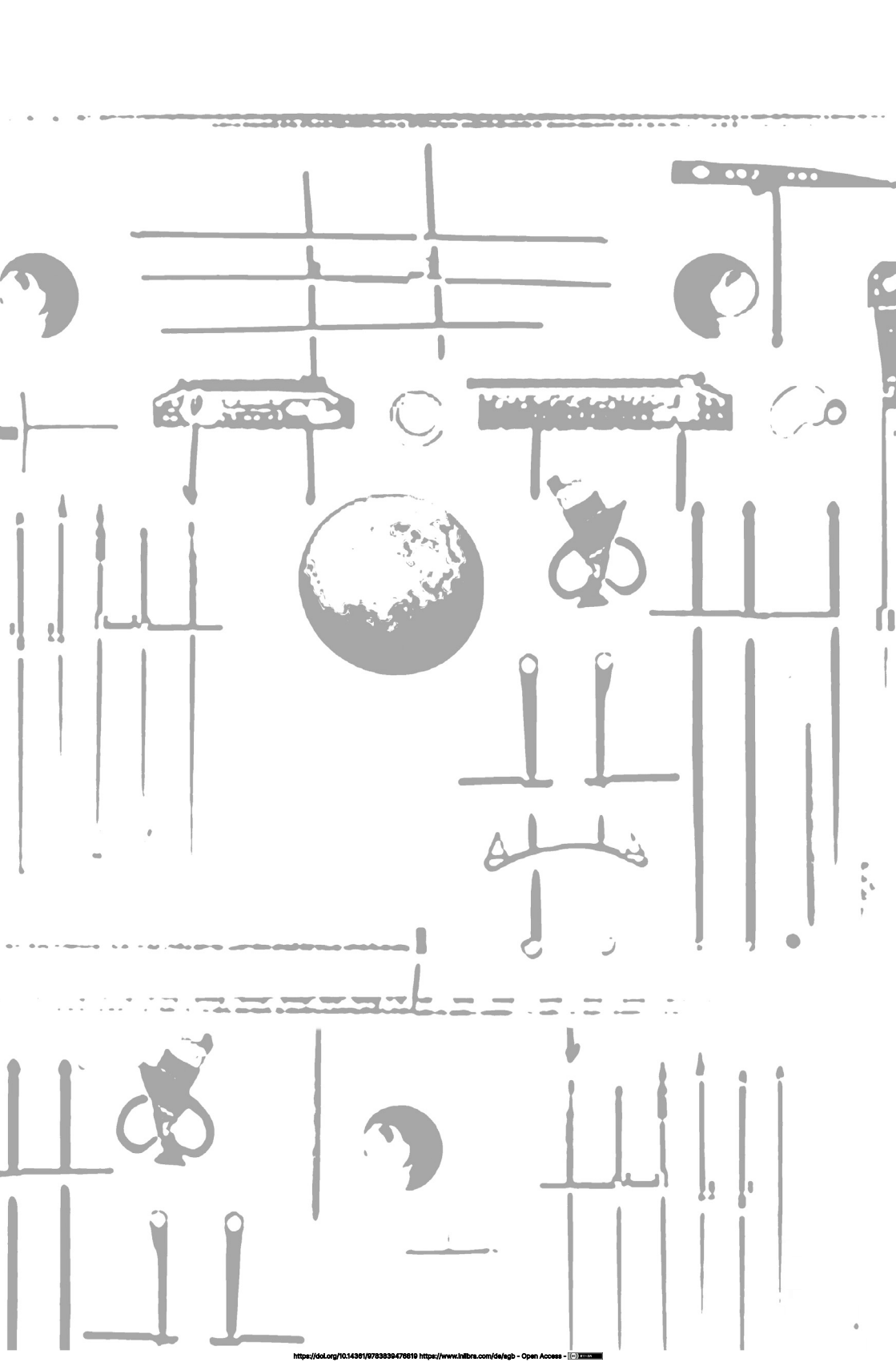
with unknown or unfamiliar forms of perception. An essential part of his research is the experience of participants as altered self-representations in the form of avatars, haptic feedback, and their behavior in mixed reality environments. The central research question concerning how actors integrate unfamiliar perceptual forms into their personal experience space is particularly important because unfamiliar experiences enable thought processes that lead to transformative sense-making.

Mattis Kuhn draws parallels between the ontology and epistemology of agential realism and aesthetic experiences to show that an essential characteristic of art is excluded from agential realism: the purposeful production of things of which we do not know what they are. The framework of agential realism takes the position that things have neither inherent properties nor clear boundaries. Instead, these emerge in "intra-actions" of agencies. Many of these agencies are constructed by us, i.e., through designed tools or structures. The article proposes works of art – "calculated alienation" – as »diffraction apparatuses« par excellence to question our ways of perceiving, thinking, and shaping the world.

Political security concepts – such as pre-emptive security policy – ask for technologies that are able to anticipate the future as precisely as possible. However, these policies can only be enforced by giving the concept of prevention an absolute character. A "collective acceptance of the future as a threat" is required for the resulting measures to be widely accepted. Christian Heck's article explores recent, data-driven prediction methods as tools to anticipate and proactively prevent future crises, conflicts, crimes, and terrorist threats, along with broader military and security service trends aimed at controlling and stabilizing the future. For this purpose, he questions the ethical and legal basis for such measures and discusses the implications for the rule of law, international law, and human rights. It is essential to understand the cultural and social consequences as well as the limits of these preemtive systems to preserve social freedom and participation in democratic processes.

The book concludes with an article by myself that discusses two completely different strategies for dealing with the unknown in the digital world: the chronos paradigm and the kairos paradigm. The chronos paradigm desires understanding, security, and predictability.

The intention here is the targeted design of our open future, for which the unknown must be avoided and systematically eliminated. On the other hand, the kairos paradigm draws from the unknown. It creates open spaces of action and looks for surprise and aesthetic experience within them. This openness and the search for the hidden makes it a suitable paradigm for engaging creatively and aesthetically with the digital.



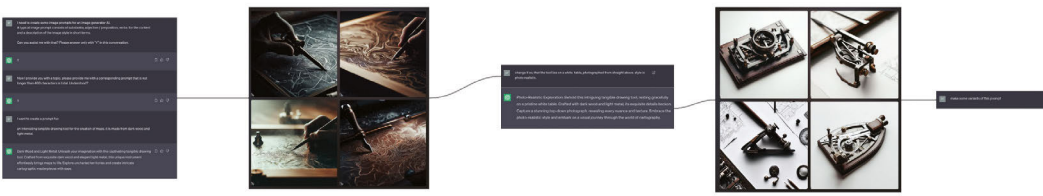
Steffen Mitschelen and Natalie Weinmann

Dialogues with the Unknown
Exploring the role of the unexpected in design processes through generative AI tools

Artificial intelligence (AI) has suddenly entered our everyday lives. Whether we use smartphones, browse websites, or shop online, we frequently interact with AI, often without being aware of it. Moreover, in professional domains like design, a variety of new tools has emerged, allegedly simplifying, enhancing, amalgamating, or supplementing processes and outcomes. This evolution prompts questions about the future roles of designers. Several AI-based tools have recently gained public attention, some of which hold significant promise for designers. First, image generators have captivated the design community by effortlessly producing high-quality images based on textual descriptions. This innovation streamlines the visualization of ideas, objects, or contexts, allowing for the creation of specific atmospheres in diverse graphical or photographic styles. Second, large language model-based chatbots offer an intriguing prospect, as they use familiar conversational language to assist in improving, summarizing, altering, or even generating textual content. Given that many designers are very good at social interactions but may struggle with writing, chatbots offer them a user-friendly approach to content creation.

In principle, all of these AI tools work in similar ways. First, large amounts of training material – either text or labeled images – are analyzed for contextual and formal relationships. Based on these findings, a data model is created that can then be searched for the

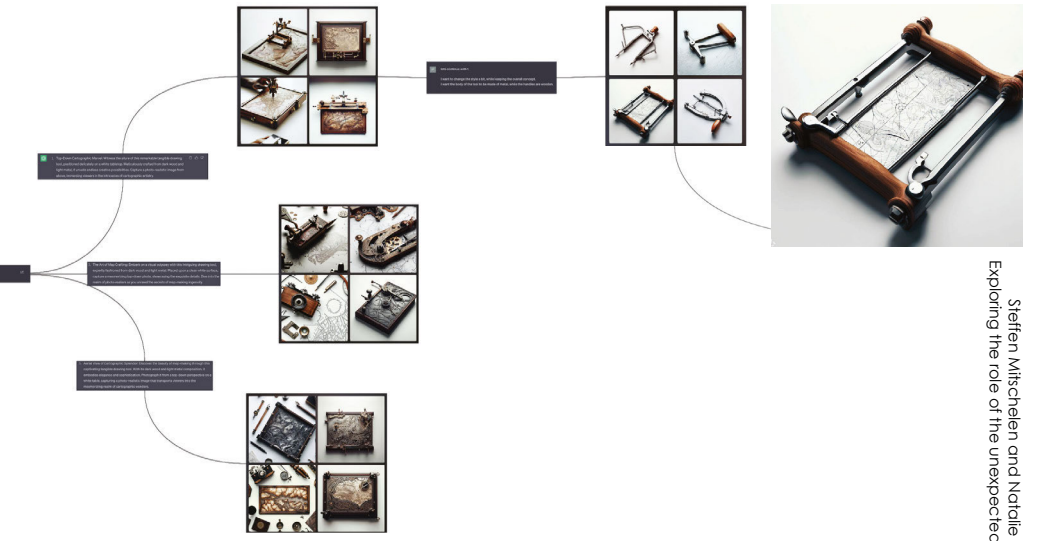
inherent relations between this content. The model thereby forms a closed space of possibilities that allows for the creation of new artifacts based on its logic. Although it would naturally be possible to experiment with the possibilities of the technology itself, most designers are bound to encounter such systems in the form of the products of large companies. Designers using such tools are thus mostly limited to moving inside of these boundaries. Interestingly, the tools that are currently available and that are already making major waves in the industry are mostly not specialized software for specialist areas but are general-purpose tools. They were not developed for specific use cases but are technological demonstrators that are intended to give an initial impression of the possibilities that such technologies can offer. The development companies seem to be primarily interested in the collection of data about the areas of application found by their users, which explains the partly uncontrollable outcome; for example, in the form of generated images.
When designers engage with these novel and largely unfamiliar tools, they most probably approach them with preconceived notions about how to use them and a belief in supposed classifications of right or wrong outcomes. However, working with AI fundamentally differs from working with conventional design tools. This raises the question of how such tools will impact the design discipline in the long run: How do they affect design processes? How will they change our understanding of the design praxis in general?



This paper reports on a workshop in which the relationships between users and tools were addressed on multiple levels to approach such fundamental questions. The workshop was part of a series of design foundation course workshops at the Coburg University of Applied Sciences and Arts. It dealt with the topic of seeing and perceiving. The workshop was jointly conceived and conducted by the authors. In preparation for the workshop, one week in advance, we introduced image generation using AI tools. Next to showing state-

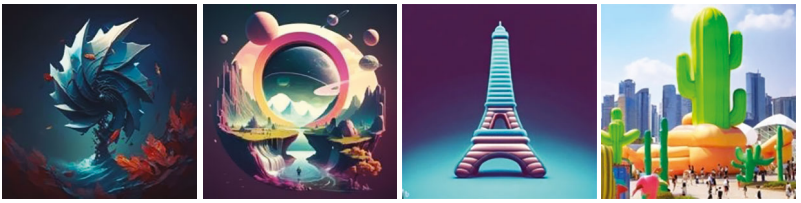
of-the-art examples, the question was discussed as to why generated images could be understood at all, even if the things depicted do not represent any real objects. Subsequently, the students were introduced to a technical pipeline that they were supposed to use in the workshop: a combination of Open AI's text generator ChatGPT[1] and Microsoft's Bing Image Creator.[2] ChatGPT was used for generating textual descriptions of objects which then served as input prompts for the Bing Image Creator. Both tools could be accessed easily and free of charge via the web browser. Their combined use allowed for a dialogical interaction between students and tools, in which images could be gradually developed in the form of a conversation between the students, ChatGPT, and the visualized text outcome by Bing. Similar workflows were since then added to the standard functionality of both, ChatGPT[3] and Bing's own Chatbot.[4] This highlights the importance of the timing of our experiment, which might already be perceived in completely different ways today.

The pipeline used for the workshop. It utilizes the combination of ChatGPT and Bing Image Creator to create generative images in a conversational situation. The steps oscillate between text inputs and image outputs.



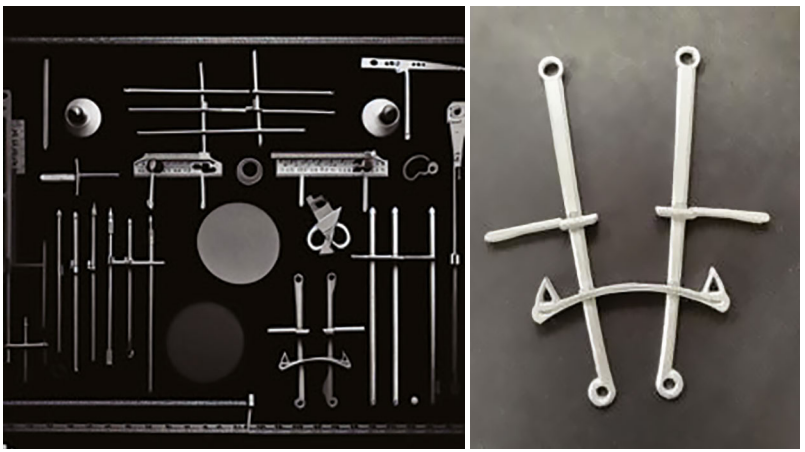
1 "ChatGPT," accessed September 27, 2023, https://chat.openai.com
2 "Bing," Bing, accessed September 27, 2023, https://www.bing.com/create
3 Will Knight, "OpenAI's Dall-E 3 Is an Art Generator Powered by ChatGPT," Wired, accessed September 27, 2023, https://www.wired.com/story/dall-e-3-open-ai-chat-gpt/
4 Yusuf Mehdi, "Create Images with Your Words - Bing Image Creator Comes to the New Bing," The Official Microsoft Blog, March 21, 2023, https://blogs.microsoft.com/blog/2023/03/21/create-images-with-your-words-bing-image-creator-comes-to-the-new-bing/

By offering this introduction in advance, we ensured that all students gathered their first experiences working with AI generators one week ahead of the workshop. We thus tried to minimize the number of technical difficulties during the workshop, which was important for us, as we planned only one day for the workshop.



Examples of the diversity of image styles that arose in the first experiments of the students with the pipeline.

The workshop itself took place on the second of June 2023, in the maker space Creapolis at the Coburg University of Applied Sciences and Arts.[5] It was conceived for students from the fourth semester of the Integrated Product Design program, and nineteen students participated in total. The workshop comprised two parts, in which students worked together in groups of two. In the first part of the workshop, the students were assigned the task of 'generating a picture of an unusual and interesting analog graphic tool' using the AI pipeline



A first experiment for the two parts of the workshop created by the tutors prior to the workshop. What could it possibly be good for?!

5 "CREAPOLIS Coburg: Connect - Create - Innovate," CREAPOLIS Coburg: connect - create - innovate, accessed September 27, 2023, https://www.creapolis-coburg.de/.

described above. In the second part, each group then needed to build a quick functional prototype of their generated tool. Here, the focus was on the question of what the generated tools might possibly be good for. For this purpose, various materials and tools were available to the students via the maker space. In addition, in order to encourage diversity in the results, we also provided them with various colors, pencils, and inks that could be used with their individual prototypes to create graphics. The students had three hours for each of the two parts. As a final submission, each group had to hand in a final text prompt and the associated generated image, a photograph of their functioning prototype, a test graphic that was made using their prototype, and a sketch highlighting and naming the main components of their tool. At the end of the day, we concluded the workshop with a quick round of presentations.

The students in the maker space Creapolis.

In the following, the workshop will be reflected based on the two different research interests of the authors. In the first part, 'How do tools speak to us?' Steffen Mitschelen explores the question of how tools suggest and transport actions. How do their functions reveal themselves to their users? Why can they be used at all? In what way do they speak to us and are thus involved in our thinking about design problems? This first part explains how the workshop was conceived to tackle such questions using a method the author calls meta-tools. It also explores some of the students' results and discusses differences in their strategies for finding solutions.

In the second part, 'A dialogue with the unknown,' Natalie Weinmann delves into how students perceive unfamiliar tools and unknown approaches during this workshop. It explores the impact of aspects such as theoretical and practical knowledge, past experiences, control, ingrained routines, and met or unmet expectations on students' actions from a retrospective perspective. This second part is primarily based on memories of students, conceived through semi-structured interviews, and complemented by observations made by the tutors during the workshop.

Part one: How do tools speak to us?
by Steffen Mitschelen

> *We live in a world filled with objects, many natural, the rest artificial. Every day we encounter thousands of objects, many of them new to us. Many of the new objects are similar to ones we already know, but many are unique, yet we manage quite well. How do we do this? Why is it that when we encounter many unusual natural objects, we know how to interact with them? Why is this true with many of the artificial, human-made objects we encounter?*[6]

The objects around us seem to speak to us, enabling us to go about our daily lives. They give us clues as to what they might be suitable for, what could be done with them, and what we must not do with them. A tree may suggest us climbing. A chair suggests sitting. And the red color of an active hotplate suggests that we would be better off not touching it. It is suggestions like these that psychologist Abraham Maslow refers to when he writes that it is "tempting, if the only tool you have is a hammer, to treat everything as if it were a nail."[7] The hammer speaks to its user, suggesting a solution that seems to be stored inside it. It issues instructions for action, namely hammering in some nails. As humans are creating tools to solve certain classes of problems, it is evident that applying any tool to a new problem means finding applications for already established procedures in new situations. Tools can thus be characterized as giving form to prefabricated solutions. Their suggestive nature guides us through their application. They are telling us how to deal with the unknown.

6 Donald A. Norman, The Design of Everyday Things, Revised and expanded edition (New York, New York: Basic Books, 2013), 10f.
7 Abraham Masslow, The Psychology of Science: A Reconnaissance (Chapel Hill: Maurice Bassett Publishing, 2002), 15.

In design, this relationship holds a special position because design, by definition, always deals with (at least partially) unknown problems and situations. For example, an architect may have the task of finding the as-yet-unknown shape for a building, while a UX designer may have to come up with a coherent experience that satisfies his only vaguely defined user group. At the same time, design processes cannot take place without the use of design tools. I define design tools here as closed material systems that can be manipulated to create or represent artifacts. They translate design problems into tangible realities, making them processible for designers.

As the design theorists Rittel and Webber highlighted, there is never one right solution to any given design problem.[8] They described such problems as wicked problems, pointing to the fact that their solutions could take an infinite number of different forms depending on which requirements are considered. Different solutions to the same design problem may even be contradictory or may lead to completely new problems! Here, the importance of a reflective handling of the suggestive character of design tools becomes very clear: different design tools will suggest completely different approaches to the same problem, which, in turn, will lead to completely different results. The architect may arrive at a very different shape for his building if he starts with pen and paper than if he uses a CAD program. The UX designer considers different aspects of his design to be important while creating an interactive prototype compared to a static one.

In this context, my main interest in the workshop was to reflect on how (design) tools speak to their users. How do they store and convey their contents? How do they suggest certain actions? And how are they guiding us in the development of solutions? Our workshop offered an experimental approach to such questions, using a method I call meta-tools. Meta-tools are experimental settings that focus on individual properties of design tools and make them tangible through experimentation. They are simultaneously applicable design tools and tools for thinking about tools.

In the first part of this chapter, I will outline the theoretical framework on which the workshop was built. It offers an insight into the suggestive nature of tools from an interface design perspective. In the

8 Horst W. J. Rittel and Melvin M. Webber, "Dilemmas in a General Theory of Planning," Policy Sciences 4, no. 2 (June 1, 1973): 155–69, https://doi.org/10.1007/BF01405730.

second part, I describe how the idea for the meta-tools was developed based on that. In the third part, I will go over some of the results that the students came up with during the workshop that show different strategies in their approaches. To conclude the first chapter of this paper, I will summarize some aspects of the experimental setting that I found particularly fruitful.

Affordances, signifiers, and mental models

In his 1979 book 'The Ecological Approach to Visual Perception,' psychologist James J. Gibson captures the suggestive nature of the things surrounding us under the term affordance. According to Gibson, the affordance of an object is "what it provides or furnishes, either for good or ill."[9] Cognitive scientist and usability engineer Don Norman later built upon Gibson's concept, making it suitable for design. He highlights that affordances are not simply attributes that could objectively be found in the things around us. He rather describes them as relationships established between individual users and objects. He defines: "An affordance is a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used."[10] Norman focuses on the fact that different things may suggest very different actions to different users: "A chair affords ('is for') support and, therefore, affords sitting. Most chairs can also be carried by a single person (they afford lifting), but some can only be lifted by a strong person or by a team of people. If young or relatively weak people cannot lift a chair, then for these people, the chair does not have that affordance, it does not afford lifting."[11] Affordances differ not only based on physical differences. Knowledge, cultural imprints, and personal experiences all play an equally important role. Looking at an unknown traffic sign does not afford the required actions. To someone who has never surfed the web, an underlined word would not afford to click. And while the glass pane of a bus stop may afford shelter to passengers, it may afford demolition to hooligans. Norman summarizes: "An affordance is a relationship. Whether an affordance exists depends upon the properties of both the object and the agent."[12]

9 James J. Gibson, The Ecological Approach to Visual Perception: Classic Edition (New York: Psychology Press, 2014), 119, https://doi.org/10.4324/9781315740218.
10 Norman, The Design of Everyday Things, 11.
11 Ibid.
12 Ibid.

The properties on the object's side, Norman calls signifiers. Signifiers are objectively present in each object. They are "signs, perceptible signals of what can be done."[13] They can send signals through all perceptible properties of an object. Functions can thus be indicated by means of all available attributes of a chosen material, such as shape, weight, size, color, sound, etc. Signifiers are the part of an affordance relationship over which designers have control while designing an artifact. Using interface design terminology, the properties on the agent's side can be described as mental models. Mental models are subjective systems of belief that each individual person holds. They determine how a user interprets the system of signifiers of a given object. Interface design luminary Jakob Nielson defines: "A mental model is what the user believes about the system at hand."[14] A mental model fuels a user's expectations of how a system behaves and leads them to approach it in certain ways. Nielson emphasizes: "A mental model is based on belief, not facts: that is, it's a model of what users know (or think they know) about a system such as your website."[15] Mental models, in contrast to the signifiers of an artifact, are never fixed. They change along with the users' experiences and learnings. A simple example of an affordance relationship between signifiers and mental models can be found in the design of doors. Every one of us has built a concept (mental model) of whether to push or pull (affordance) a door when looking at its knob or handle (signifier). And every one of us also knows the feeling of being disappointed by such assumptions.

In the following, I describe the idea for the meta-tools of this workshop and how they were conceptualized to reflect on the affordance relationships we form with tools.

AI excavations

As explained above, well-defined tools utilize clear signifiers to tell their target user group what they are made for and how they could be handled. They address their mental models, affording them the applications of certain types of actions. To enable the students to reflect on such relationships, the initial idea for the workshop setup was to

13 Ibid. xv.
14 Jakob Nielsen, "Mental Models and User Experience Design," Nielsen Norman Group, accessed September 20, 2023, https://www.nngroup.com/articles/mental-models/.
15 Ibid.

A series of generated tools that were created during the preparation for the workshop. Each of them clearly contains signifiers that afford certain ways of handling them. As the image prompts were very detailed descriptions generated with ChatGPT, the generated images proved to be equally detailed.

experiment with tools that no one intentionally designed and, for that reason, obviously do not carry any intended functionality. This is where the AI generators came into play. When asked for images of tools, the Bing Image Creator produces some interesting results. Most of these images can immediately be recognized as showing some sort of tool. The reader will recognize familiar elements within them, such as handles, scales, adjustable angles, drawing tips, knife blades, etc. However, their purpose remains entirely unclear. Of course, this is true because they have no purpose. The associative power of the general-purpose image AI – which was not specifically trained on the individual parts of tools – simply assembles visual elements, each of which can often be found in tools. What we are looking at here are collages of common signifiers that have been arranged and combined in uncommon ways. Interestingly, that is already sufficient to arouse curiosity: How do the depicted tools work? What are they made from? What could they be good for?

The idea of using unfamiliar elements to reflect on affordances and mental models in the application of tools was directly inspired by another discipline interested in such questions, namely experimental archaeology. Experimental archaeologists are dealing with excavated artifacts and ask themselves how they might have been used in the past. Their practice is "the use of controllable, imitative experiments to replicate and/or simulate past objects, materials, processes, behaviors," etc.[16] Experimental Archaeologists are looking at ancient tools to develop a plausible theory for their purpose. To test their theories, they take an experimental approach. If they want to know – for example – whether certain materials could have been worked on with a stone axe, they simply try it out. For this purpose, they would go and build a replica of the axe to put it to the test.

What is interesting in the context of this paper is not only, that experimental archaeologists clearly reflect on signifiers. Moreover, they reflect on them from a certain perspective. To form a plausible theory of how a stone axe would have been used, it is first necessary to come up with a plausible mental model of a caveman. The archaeologists Fox et al. summarize: "Starting from this perspective,

16 Heather Margaret-Louise Miller, Archaeological Approaches to Technology (Amsterdam, Boston: Elsevier/Academic Press, 2007), 34.

it is not only necessary to examine several possible applications offered by the materiality of the artifact. Rather, it is also a matter of determining exactly which of these applications fits into each social context."[17] Such a twofold reflective behavior was the intention underlying the workshop.

Similar to the archaeologist, while working with the generated images and on the functional prototypes of their tools, the students had to constantly reflect on both the signifiers in the images, and their mental models that led them to see certain functions within them. The second point was emphasized by the fact that the students had to work in groups. Discussions regarding the usefulness or uselessness of the individual results and their potential applicability quickly developed among all groups. To agree to an approach, they needed to consciously adapt their mental models throughout the generating, prototyping, and testing of their tools. The resulting mental models are particularly evident in the labeled sketches of the tools the students had to hand in. On those, it becomes visible which signifiers of the initial images came out to be the most relevant throughout the process, how these were interpreted, and what aspects they ignored. Next, I review some of the results and describe some interesting observations I made there.

Exemplary results

In the following, I go over the results of four of the groups. Each of them illustrates a different approach that was taken in the interpretation of the generated images. These approaches to interpretation are (1) Function-, (2) Aesthetic-, (3) Mechanism-, and (4) Material-oriented. They led to very different affordance relationships between the students and their generated images. They strongly influenced the prototyping processes, the students' priorities in their results, as well as the possible usages of their finished tools. These examples highlight differences in the mental models of the groups and how these mental models were steering them through the workshop.

17 Richard Fox, Diamantis Panagiotopoulos, and Christina Tsouparopoulou, "Affordanz," in Affordanz (De Gruyter, 2015), 69, https://doi.org/10.1515/9783110371291.63.

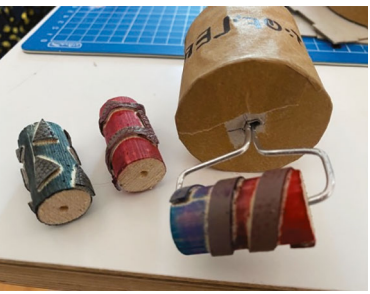
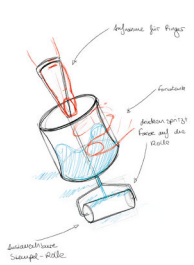
1. *Function-oriented interpretation: The T:OF:LER*




From left to right: The generated image, the first prototype, and two of the patterns created by using exchangeable rolls.

During the generation phase with ChatGPT and Bing, the group quickly decided on a certain functionality they wanted to create. They chose to opt for the combination of two tools with which they were already familiar, namely ink rolls and stamps. They used the pipeline to ascertain what such a combination could look like by asking the AI tools for very specific things. The generated image that they came up with shows some kind of roll that gets pushed over a surface covered in uniform patterns.

While the roll in the picture does not seem to contain any sign of a pattern, their initial idea guided the team to read the picture as if the roll would leave a trace of regular patterns behind. In the prototype they built later, this function was at the center of their attention. Their self-set mental model strongly influenced their interpretation of the found signifiers. The implementation in the final prototype was achieved by gluing cut-out pieces of leather to an old cork. The students' idea about this functionality was so strong that they even created a variety of exchangeable stamp rolls that could be used to produce a variety of different patterns.


From left to right: The exchangeable rolls, the schematic drawing of the tool, and a second, more advanced prototype.

Their focus on the creation of patterns made other aspects of the image fade into the background. Until the very end, they were unsure what the large cylindrical element at the center of the tool could possibly be good for. They started talking about it long after the prototype was finished, as they found it to be rather annoying for their function. They decided that, in the next version, it could be an ink tank that could be squeezed to drip ink on the roll. They captured this idea in their sketch of the tool and implemented it in a second prototype that they built after the workshop.

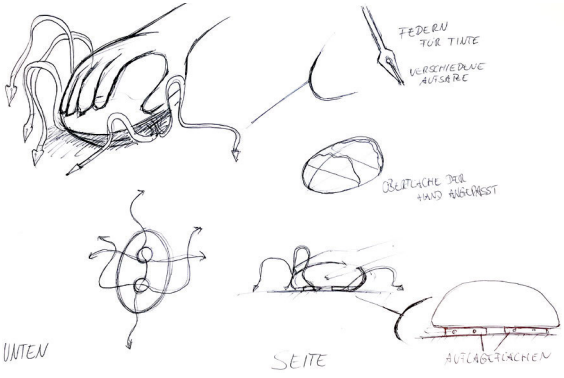
The name of the tool started as a joke. The image generators back then often included broken-looking text fragments in their results. In one of their generated images, the students found the word 'T:OF:LER.' What started as a joke, the group quickly adapted as a name when they were talking about their tool. The way in which they made use of this is a good example of how even unassuming signifiers can be loaded with meaning when they are found and interpreted by the right mental model. Ultimately, all generated results only become meaningful when they are considered.

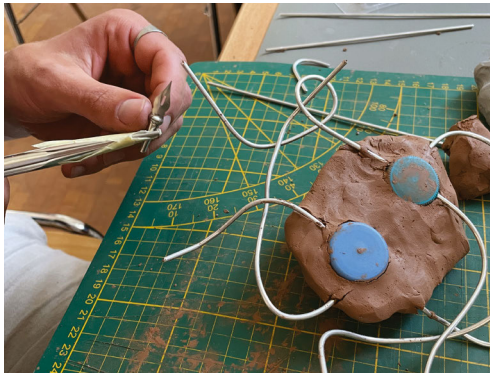
2. ***Aesthetic-oriented interpretation: The Octopen***

From left to right: The generated image, the prototype, and a resulting test graphic.

This group was instantly mesmerized by the sci-fi look of their initial generated images. The unusual visuals that they were able to create using the AI pipeline guided them throughout their entire process. While they very much liked their results, it took them some effort to come up with something they could consider to be a graphic tool in the broadest sense. Therefore, at one point, they started to write their image prompts by themselves, relying on keywords that they found to

be useful in working with ChatGPT to generate the desired look. After they generated their final image, their work took a very associative character. The elements of the image were interpreted as organic tentacles, which led them to refer to the tool as a kind of octopus pen, hence the name 'Octopen.' They thought of it as crawling across a sheet of paper, leaving behind a trail of ink. This inspired them to think of the arms or tentacles as somehow mechanically moving, spitting ink from their tips. The body then would act as a container for the ink.

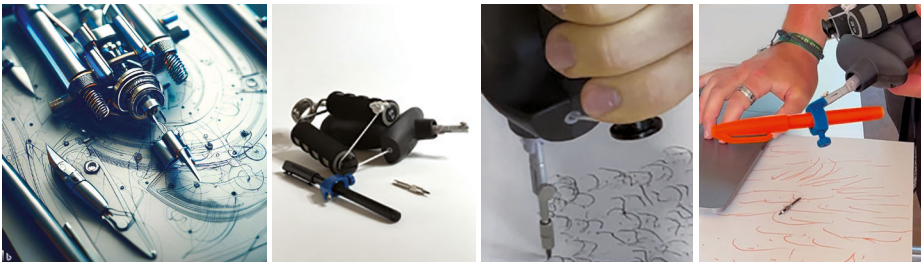




From left to right: The schematic drawing of the tool and a scene of the material prototyping process.

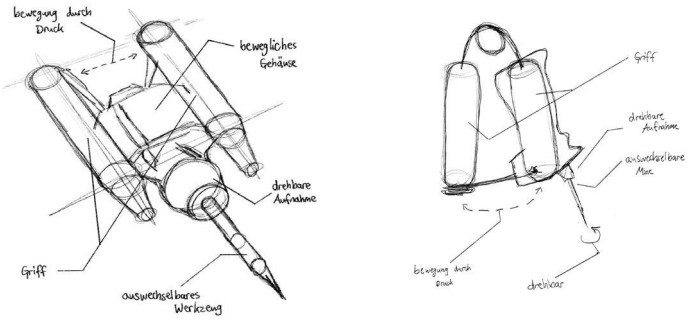
Nevertheless, aesthetics and ergonomic considerations were more important to them during the prototyping process than the implementation of any mechanisms. For that reason, they created a rather ridged structure from clay and wire for the prototype. As they assumed the object could be held and pushed around pleasantly with one hand, its clay body became reminiscent of a computer mouse. At the end of the wires, they attached ink feather tips. To test the prototype, each tip needed to be inked up individually. The wires could be bent as desired to create different patterns while pushing the tool over the paper. Based on different patterns that the different configurations of the tentacles could produce, the group continued to discuss what possible movement for the tentacles would be desirable for the next version of the tool.

3. *Mechanism-oriented interpretation: The PressPen*



From left to right: The generated image, the prototype, and the creation of different patterns using the tool.

This group generated the final image of the tool that they ended up using very early during the first few minutes of the workshop. While they kept on generating further images for a little longer, they always returned to their favorite one. They were fascinated by the results' mechanical character, which guided them in the interpretation of its signifiers. While the picture also contained aesthetically interesting features, like different materials, corrugations, or even a drawing beneath the tool, they focused exclusively on the mechanical characteristics that the image afforded to them.
In their first sketch, they captured the mechanism they found. Here they agreed on the idea that the tool needs to be squeezed together.



On the left: An analytic sketch of the mechanism of the generated image. On the right: The schematic drawing of the final prototype.

This action would then trigger a rotational movement in an interchangeable pen tip on the front of the tool.
I was quite fascinated by how they approached the prototyping

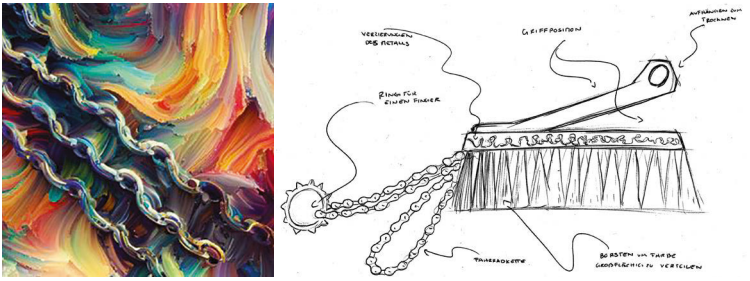
of this functional structure. They went to a non-food-discounter near the university and returned with a few different products: a finger trainer that was reminiscent of the squeezing movement, a toy propeller launcher that contained the circular motion they were looking for, and a drawing compass, that represented the mechanism of interchangeable pen tips. They then disassembled these objects and put them together to form their prototype. A second sketch they made after they finished the prototype shows a similar mechanism, to what they found in their generated image but in a completely different form factor. They were so engaged in creating the mechanism that until the very end they had no clear idea what a possible application for their prototype could be. They joked that this tool and its seemingly uncontrollable character would be their drawing teacher's nightmare. However, when they tested it, both students were quite delighted by the unexpectedly wide variety of quick pencil patterns that could be created with it. These patterns differed depending on the way the tool was held and which tip they attached to it. Based on the mechanism, they named their tool 'PressPen.'

4. ***Material-oriented interpretation: The Chaint***

From left to right: The generated image, the built prototype, and a test graphic produced with the tool.

Both members of this group were connected to us via Zoom and thus had no access to the materials and tools in the maker space. The fact that they were limited to the things they had at home led them to adopt an interesting upcycling approach: they asked ChatGPT for a list of household items that could be used with paint or ink to create interesting graphics. From the list they received, they decided to go with a combination of two of the suggested things, namely a sweep and an old bicycle chain. They stated that they went along with these two things, as they happened to have them both available.

Taking those two elements as a base, they started to generate images that were combinations of them until they received a result that they found to be interesting and interpreted as tool-like.
As they were still unsure about how that tool could be applied after they finished building it, they took an interesting additional step: they asked ChatGPT for an image prompt that would create images of what results could come out when using their tool. Based on these graphics, they built their mental model of how the tool could be handled, which became visible in their schematic drawing. They did that by trying to figure out how to handle the tool to come close to the generated visuals.



From left to right: A generated visual of a possible result and the schematic sketch of the group that tries to ascertain how to handle the tool to come to such a result.

The students then went on and put their theories to the test. Therefore, they applied paint to a piece of paper and distributed it in different ways using their tool. While they seemed to be slightly unsatisfied with the graphics that they could create with their prototype in comparison to the computer-generated ones, I found this approach to be very inspiring. The reconstruction of a graphic tool – starting from a goal image – could be an entire meta-tool workshop on its own.

Concluding thoughts on the workshop

Tools speak to us by addressing our mental models through signifiers. Thereby, they afford certain ways of use that lead to different approaches to problems. The presented projects highlight how affordance relationships between users and tools are established and how such relationships form our expectations towards the tools we are using. The workshop can be understood as an intervention to classical design processes. By reversing the usual design paradigm of 'form follows function' to 'function follows form,' it focuses on the impact of affordances on problem-solving behavior.

The process clearly showcased the importance of the designer's interpretation skills. This offers a hint about what the design discipline may look like in the future and how it may remain relevant in a world of generative AIs. One could even argue that the designer's ability to make sense of unknown situations and objects becomes increasingly important as increasingly more things become generatable. To sum it up with the philosopher of technology Don Ihde: "A technological object, whatever else it is, becomes what it 'is' through its uses,"[18] and – I would like to emphasize – through its users. This is one way of harnessing the potential of AI technologies for the creation of new things and to escape the repetitive nature of generative technologies. To conclude this chapter, I list some aspects of the planning and implementation of the workshop that I found particularly fruitful, both in preparing the tasks and in encouraging reflective behavior among the participants. Aspects 1-8 can be considered patterns that could find their way into the planning and implementation of further meta-tool workshops. The last three points (9-11) describe some further ideas, that emerged during the workshop, and that I would propose for further experimentation.

1. In the preparation of the workshop, the simple *theoretical framework* of signifiers, mental models, and affordances was very useful in outlining a clear goal for what exactly should be reflected on. It also made it very easy to talk about image generators and what they produce.
2. The *working metaphor* of experimental archaeology proved to be a great way to simply convey the theoretical framework and set the tone of the workshop. It provided an intuitive understanding of a process that could otherwise have been somewhat confusing for the participants.
3. The relatively *open task* that simply asked for an unusual analog graphic tool forced the students to think about their own mental models and presumptions.
4. The same was true for the *atmosphere* of the maker space and the wide variety of equipment and materials available there. It encouraged the students to make informed decisions about what tools and materials to use.

18 Don Ihde, Technology and the Lifeworld: From Garden to Earth, Nachdr., The Indiana Series in the Philosophy of Technology 560 (Bloomington, Ind.: Indiana University Press, 1996), 70.

5. Thereby, the *pipeline* of the two chosen easy-to-use but at the time difficult-to-control AI tools, ChatGPT and Bing, kept the tasks very free yet subject to explicit constraints.
6. The fact that *interpretation* was a necessary part of all of the steps of the process promoted discussions among all participants. This encouraged reflective behavior in all design decisions.
7. The short *time frame* for the individual tasks, in combination with the clear requirements for what had to be submitted at the end, let the focus on decision-making. This was useful as it strengthened the students' sense that there would have been alternative paths along the way that were not taken.
8. I found the *schematic drawings* particularly insightful. The labeling of parts offered a good way of visualizing the reflective processes of the students. This could have been thought further; for example, by letting the students write a manual for their tools.
9. If we had had more time on a second day, it would have been very interesting to ask the students to tackle a *unified design task* with their new tools. This could have been used to reflect on the different solutions that their tools suggested to the same question (e.g. design a promotional poster for your study program).
10. The tools could also have been evaluated further by *exchanging the tools* between the groups and letting the other groups work with them. This could have revealed how their understanding of them differed and what could have been learned from that.
11. As highlighted above, the process of *starting from a final graphic* that the 'Chaint' group generated prior to producing their prototype could be the foundation of a future workshop.

Part two: A dialogue with the unknown
by Natalie Weinmann

> *Maybe it was also a kind of debate to be honest. In the beginning, you want to say what you want to get rid of or what you think is the right opinion … But then somehow there is a counterattack or a completely different opinion and then you try to respond to it again and then you always respond to the other person or non-person. Then maybe in the end you have reached a compromise through the result that we have chosen. Or worked out. Developed.*[19]

The introductory quote comes from a design student who reflects on her experiences during the workshop six weeks later. It captures her perception of the workshop process, emphasizing the effort needed to master the unfamiliar tools to create desired outcomes. Her description of the process goes beyond tool usage, resembling a social interaction, evident in her use of terms like 'debate' and 'opinion' to characterize her interaction with the AI. This not only raises questions about how designers approach new and unknown tools but also sparks curiosity about their experiences and recollections. This chapter delves into specific memories of two participating students, aiming to unravel the significance of retrospection as a valuable teaching tool in design education.

My motivation in this workshop was to provide students with an initial encounter with unfamiliar tools in a playful manner, creating a secure environment for them to explore the tool's limits and possibilities experimentally. This engagement was facilitated through a dialogical interaction with both the tool and the team partner. Post-workshop semi-structured interviews were conducted to explore the students' remembered experiences and enable retrospection. This additional information, unattainable through observations alone, centers on the students' individual perspectives and memories, enriching our understanding of their viewpoints and the situations they encountered. The dialogical nature of the interviews, akin to a trialogue involving the two students and myself as one of the tutors, contributed valuable pedagogical insights.

In the initial section, I will provide various examples to illustrate the students' recollections concerning their encounters with unfamiliarity throughout the process. Subsequently, I will delve into

19 Nadja, Student, Interviews by the author. July 2023.

the students' perceptions of unknown tools and their interpretation of a 'typical design process.' In addition, I aim to discuss key aspects of the workshop, including issues related to control or lack thereof, past experiences, ingrained routines, expectations, the overall workshop setup, and how students navigate emotions and feelings in the design process. In conclusion, I will outline the research's limitations and implications, emphasizing valuable insights. Finally, I will emphasize the need to align higher education with future demands when encountering unfamiliar tools, proposing self-reflection formats as a transformative academic approach.

Dialogues

A crucial element in this workshop was the dialogical exchange, necessitating students to engage with AI programs in a dialogical manner. The initial phase of the workshop mirrored a sparring process among humans, involving dialogical communication, occasionally entailing disputes, as noted in the preceding quote. Students had to discover how to interact with these programs, first through chat with ChatGPT and subsequently by allowing Bing to generate images with limited control. Upon reviewing the written conversations students had with ChatGPT, one might easily mistake them for interactions with a real person. Polite phrases like "Dear ChatGPT. I need … Please give me …" marked the beginning of conversations, reflecting an anthropomorphic interaction. Don Ihde categorizes this relationship between students and technology as an alterity relation, making them encounter "the otherness of technology."[20] Their approach was shaped by experiences in conversational interactions with humans, given that ChatGPT's user interface resembled that of conventional chat programs. A participating student, without any experience in using AI programs, remarked:

> *The first words with the AI were completely strange. I really thought I was chatting with someone somewhere else in the world. Because I was polite, and this AI also answered me politely, and that was a very, very creepy feeling.*[21]

In this human-technology dynamic, this student also recalled encountering the "problem of anthropomorphism, the personalization

20 Ihde, Technology and the Lifeworld, 97-98.
21 Vanessa, Student, Interviews by the author. July 2023.

of artifacts."[22] Reflecting on her behavior, she recognized the uncanny feeling associated with conversing with technology instead of a human being. Despite this realization, she struggled to alter her interaction style, as could be viewed in the chat history. Conversely, other students employed commanding communication, issuing directives like 'Describe' or 'Shorten,' initiating varied dialogues that impacted the outcomes. This student seemed to draw from past experiences of commanding technology, shaping a commanding interaction.

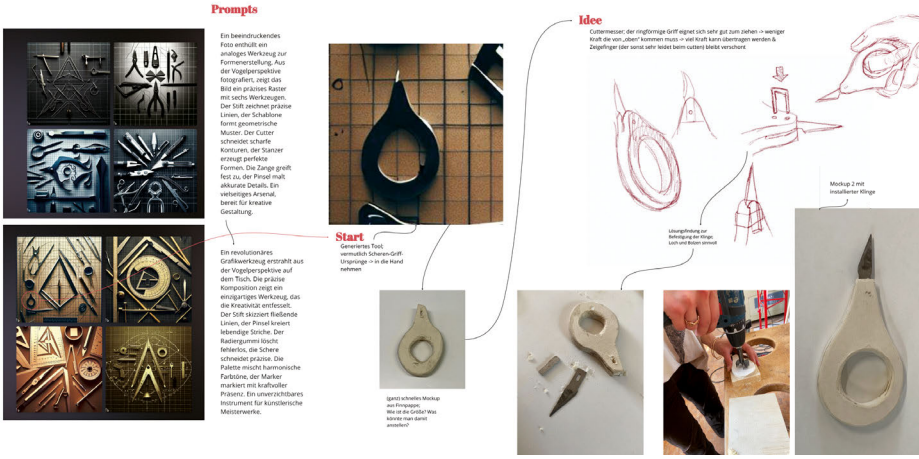
The question of acceptance and letting go of control played an important role during the whole workshop, which is evident in the written dialogues with the AI. Students sought to minimize undesired program reactions by specifying, correcting, or changing specific words, believing it would grant them greater control over the seemingly random feedback. This can be viewed as an uncertainty absorption mechanism, aligning with the organizational theory of Herbert A. Simon and James G. March. Students needed to trust the conversation without constant questioning, as each reformulation in the dialogue had the potential to alter the entire process significantly. Sociologist Dirk Baecker articulated this trust concept:

> *Any communication can reach a point at any time where it can only find the courage to trust itself by taking over previous communication unchecked and encouraging subsequent communication with its trust in itself. Just as in the organisation, however, this trust is not a blind trust, but a constantly checked trust. It reaches forward and back, introduces the past into the future and the future into the present; it relies on experience and anticipates future experience; it orients itself to approval and rejection and relies on finding further approval and rejection.*[23]

Trusting themselves and the process proved challenging for some students, which was evident in the emotional reactions observed by us tutors. As explored in the initial chapter, the second part of the workshop also constituted a form of dialogue, with tools communicating with the students. The students had to interpret relevant signifiers and construct a chosen visualized object. While building and testing the prototypes, the students gained more understanding of their possible properties and uses. In contrast to the first part of the workshop, which involved a dialogue with AI programs using language

22 Ihde, Technology and the Lifeworld, 98.

23 Dirk Baecker, "Designvertrauen: Unsicherheitsabsorption in Der Nächsten Gesellschaft," in Merkur, vol. 799 (Stuttgart: Klett-Cotta, 2015), 89 (translated by the author); See also Charles F. Sabel, "Studied Trust: Building New Forms of Cooperation in a Volatile Economy.," Human Relations, 1993; Niklas Luhmann, Vertrauen: e. Mechanismus d. Reduktion sozialer Komplexität (Enke, 1973).



Non-verbal dialogue between students and prototyping materials during the exploration process.

and visuals, the second part featured a non-verbal dialogue with the crafted tools through hands-on interaction.

Focusing on how students navigate the unknown with unfamiliar tools, I integrated observations with semi-structured interviews six weeks post-workshop. This text emphasizes the distinction between students' actions and their memory thereof through their verbal accounts. It acknowledges the influence of factors like prior knowledge, memory, or specific self-perception. This special form of introspection, called retrospection, relies on the memory of experienced events.[24] During this interview, "participants verbalize a variety of different thoughts while carrying out stimulated recall," as Petra Knorr highlights. She further notes: "The collected data reveal that some of the participants' responses do refer to thoughts that occurred during the action whereas other responses refer to hindsight thoughts that were only evoked during the retrospective interview."[25] Hence, these interviews may not unveil the actual processes or emotions, but they provide insights into the interviewees' remembered perceptions, serving as an interpretation of the events.[26]

Four groups were interviewed in total, and one group particularly stood out in terms of their process, team dynamics, individual behaviors, reactions, and backgrounds. Consequently, I will concentrate

24 Cf. Karen Schramm, and Lena Heine. 'Introspektion.' In Forschungsmethoden in der Fremdsprachendidaktik: Ein Handbuch, edited by Daniela Caspari, Friederike Klippel, Michael K. Legutke, and Karen Schramm, 181-189. (Narr, 2016).

25 Petra Knorr, 'Zur Differenzierung retrospektiver verbaler Daten: Protokolle Lauten Erinnerns erheben, verstehen und analysieren.' In Introspektive Verfahren und Qualitative Inhaltsanalyse in der Fremdsprachenforschung, edited by Karin Aguado, Lena Heine, and Karen Schramm, 31–53. (Peter Lang, 2013), 31.

26 Cf. Cornelia Helfferich, *Die Qualität qualitativer Daten: Manual für die Durchführung qualitativer Interviews.* 4th ed. (Wiesbaden: VS, Verl. für Sozialwiss, 2011), 31.

on this specific group. All subsequent quotes without direct reference are extracted from the recorded interview with two students called Nadja and Niklas. The translation into English was provided by me.[27]

Perceptions of the unknown tools

The selected team stood out in my research due to their contrasting reactions when faced with unfamiliar programs and unforeseeable results, as observed by the tutors. The team comprised Niklas – a fourth-semester student – and Nadja, an eighth-semester student. Nadja vividly recalled perceiving the unforeseeable as a loss of control triggered by the outcomes Bing produced. She described such a moment, stating: "It was completely in the wrong direction. But you could never really know which word would somehow make the whole construct collapse again." Nadja's memory suggests preconceived notions about a process having a right and wrong way of handling such a tool. Coupled with her assumed sense of control due to some more predictable results at the beginning of the process, she was genuinely surprised by the outcomes when they continued to simply alter single words in the prompt. Her use of terms like 'wrong direction' and 'the whole construct collapse' illustrates the impact of the unknown process and the partly uncontrollable programs on her. By contrast, Niklas remembered the same process differently, describing the program's unforeseeable results as 'interesting' and

27 Weinmann, Interview mit Nadja und Niklas zum Workshop 'See.'

recognizing their potential through experimentation. He remarked, "you sit there and enter something full of expectation, and then the one thing comes that we have been waiting for all this time." According to Niklas' memory, the results produced by the unknown program were awaited with great optimism.

Both memories were consistent with our observations made during the workshop. The difference in how they described these moments resembled how they behaved during the workshop. This harbors individual expectations not only for the results but also for the process itself. However, they both agreed on remembering perceiving a similar moment when they inserted the information 'used by hand' into their prompt. They recalled having specific expectations of receiving more graphic tools designed for manual use but were surprised to find images primarily featuring hands, often disregarding the tools completely. This unexpected shift irritated them. Drawing on Luhmann's understanding of irritation[28], the students encountered disruptions, surprises, or deviations based on expectation structures. One can react to this with deviation, ignorance, or structural change, of which the latter was done by these two students. They had to change their approach to move forward.

A series of unforeseeable outcomes generated with Bing by Niklas and Nadja. After inserting 'used by hand' into the prompts, suddenly, the focus shifted from showing tools to primarily highlighting hands.

The students' initial approach to unfamiliar tools and their reaction to unpredictable results were influenced by their expectations of a structured design process. In the subsequent sections, I will discuss what these design students consider to be a 'typical design process' and how it shaped their expectations.

28 Cf. Niklas Luhmann, Die Gesellschaft der Gesellschaft. 1st ed. Vol. 2. Suhrkamp-Taschenbuch Wissenschaft 1360. (Frankfurt am Main: Suhrkamp, 1997), 790.

A typical design process

In the interview, both Nadja and Niklas labeled the AI programs as 'inspiration tools,' likening them to search engines and platforms like Google or Pinterest. They stressed that these tools recombine existing elements instead of creating entirely new things, fostering an expectation of predictability. Nadja's mention of "a feeling of superiority over the machine" reflected her perspective on interacting with these AI tools. Attending an introductory lecture a week before the workshop, Niklas and Nadja were exposed to examples, especially those featuring a grid view for creating multiple tools within a single image. The presented image primed their expectations, leading them to strongly anticipate such a view in their results. This expectation limited their perception, making them overlook the potential in images without the grid view, a realization that occurred weeks later.

Two approaches for creating images with Bing. On the left: Atmospheric images in perspective with a single visible tool only. On the right: An immense collection of tools shown in grid view.

Niklas also referenced their perception of a 'usual' or 'typical' design process, seemingly representing industry practices. This process, which they learned in a different course, follows a linear sequence: initiation, research, analysis, ideation, realization, and launch.[29] Our workshop introduced an inverted process, challenging their accustomed methodology. While entering their ideas into Bing, akin to simultaneous researching, sketching, and ideating, they were confronted

29 Wolfgang Schabbach, "Designpilot," accessed August 31, 2023, https://www.designpilot.info/toolbox/.

with launch-like images but lacked a concrete use case based on which they could follow the sequence.

On the one hand, the practical know-how from those past courses enabled them to follow a design process under controlled and predictable conditions but exposed a lack of comprehensive understanding of underlying principles. This absence of theoretical knowledge (knowing-that) impacted their ability to adapt approaches to various, unknown, or novel situations in the design field. On the other hand, they had some theoretical knowledge of how and why their 'typical design process' has to be approached. Still, they did not have the embodied practical experiences of dealing productively with unknown situations (knowing-how), which is a crucial part of any creative practice.[30] This specific type of knowledge involves always controlled and uncontrollable forms of action, which will be explained in the coming section.

Controllability

In the inverted process of this workshop, students faced challenges due to a lack of theoretical understanding regarding when and how to apply specific design methods (and when they do not make sense). Additionally, they also gathered limited practical experience in handling unknown situations. For instance, attempting to refine results by adding the phrase 'used by hand' on Bing resulted in unpredictable outcomes, disrupting their planned approach, and leading to irritation. The result was an entirely new style of images that were incomparable to the previous ones. Reflecting on this experience, Nadja noted, "The human brain always tries to foresee what the result will be … And maybe this experience of this structure, which you normally have in the design process, didn't help … or rather confused [us]." This quote illustrates how the structured thinking inherent in their learned design process might hinder adaptability. In retrospect, Nadja discovers and expresses her need for structure and control, emphasizing the importance of predictability during the workshop: "You gradually find out in which direction and with which words … you get the AI in the direction you want it to go." Hence, in hindsight, she also focused on the necessity of control in a design process, not considering the confusion and lack of structure

30 For a more detailed definition of knowledge, see also Tolksdorf, Stefan, ed. Conceptions of Knowledge. Berlin Studies in Knowledge Research, v. 4. (Berlin; Boston: De Gruyter, 2012).

during the workshop as somewhat fruitful. Nevertheless, through experimentation, she gained new insights into interacting with the unfamiliar AI tool.

Niklas initially found the workshop challenging as it also deviated from his expectations. However, a transformative moment occurred when the team abandoned their familiar design approach, allowing for a new perspective on uncontrollable outcomes. He recalls that once they had a prompt that produced a picture displaying multiple tools, each time they reused the corresponding text, new useful results showed up. This made them both feel very enthusiastic and suggested a feeling of control.

Observing the workshop, we recognized that prior experiences with AI tools undoubtedly eased their participation and expedited the start. However, memories revealed the development of specific expectations and a strong desire for control. As they became more acquainted with framing texts using ChatGPT, they anticipated a smoother, more controllable process with Bing. This anticipation is linked to routines, in which the students follow a sequence of actions based on past experiences. This could be habits in working with digital tools, including text command fields, hence long-established routines. Furthermore, recent familiar responses from ChatGPT can trigger automatic behaviors and constitute specific expectations. Next, I will therefore focus on how routines influenced action in this design process.

Actions based on routines

During their early design studies, these students acquired fundamental skills in structuring design processes systematically. They became adept at using various analog and digital methods and tools, knowing how to apply them optimally. However, as Nadja mentioned, these structured skills, ingrained through repetition without comprehensive understanding, proved confusing in this workshop. The students were accustomed to following a routine and applying tools and methods they knew well, but they struggled when confronted with unforeseeable moments, deviating from their trained structure. Their expertise in platforms like Google or Pinterest did not seamlessly translate to Bing, as exemplified by the hands-related examples, and attempts to delve deeper did

not yield similar results. Through trial and error, they developed new skills, such as reiterating the generation process without altering the prompt, resulting in slightly more comparable outcomes, as Niklas recalled. Relevant for the second part of the workshop, the students possessed valuable skills and routines, such as model making, handling craft tools, and machinery use. Unfortunately, this led to routine-based judgment, which influenced their choice of an object seemingly easy to build.

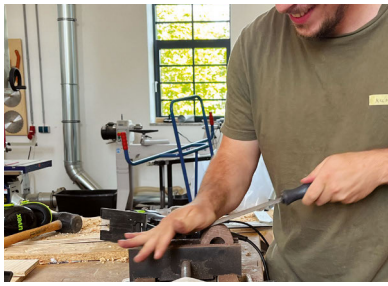
In hindsight, the value of further unconscious actions became apparent. Their photography skills aided in evaluating generated images and recognizing nuances in style and perspective. For example, they reacted differently to atmospheric images compared to those in a top view, commonly encountered in viewports from CAD programs. Additionally, they approached interpreting generated images similarly to examining hand-drawn sketches as both students jointly reflected. They relied on a skill very common in design: finding meaning through interpretation without explicit explanation.

Faced with frustration, at one point, a routine shift, or 'break,' occurred. Initially, both Nadja and Niklas worked on the same laptop, with one person inputting text into ChatGPT and prompts into Bing while the other observed, suggested ideas, and took notes. However, after encountering persistent frustration with the results, Niklas decided to shift to working simultaneously on his laptop. This 'break,' as they referred to it, interrupted their existing process and allowed for a fresh start, similar to beginning with a blank sheet of paper when drawing with a pencil. Seen as an event, French philosopher Henri Bergson explains that those moments have the potential to break with existing orders and enable establishing new ones.[31] For Niklas, the frustration led to action, interrupting the process flow, and allowing the team a new process structure, which was very present in his memory. Working on a new computer with no recorded work history in ChatGPT or Bing prevented his past interactions from influencing new actions.

In the second part of the workshop, the prototyping phase, students built a chosen tool and intuitively engaged with it. This mirrored their approach to familiar design tools, as a regular practice from their known design process routine. In this routine, after the concept and drawing

31 Cf. Henri Bergson, Schöpferische Entwicklung (Jena: E. Diederichs, 1912), 278.

Niklas and Nadja sitting next to each other sharing one laptop in the beginning compared to other students working with two laptops.



Niklas feels much more comfortable working in the workshop using familiar tools such as a saw and file to shape a piece of timber.

phase comes the phase of building and testing a prototype. The only difference is the necessity of still figuring out how to best use the built tool. For the two students, this second part of the workshop did not seem as arousing since they did not spend a lot of time recollecting their memories during the interview in comparison to the first part.

Observationally, the moments described unveiled the unconscious use of the students' acquired practical skills: photography expertise, interpretation proficiency, the ability to interrupt and restart a process, and the possibility of discovering various ways to use a tool through iterations. These skills, developed through consistent practice over time, were applied with minimal conscious thought, showcasing intuitive actions rather than purposeful decisions. Referring to Michael Polanyi's quote: "we can know more than we can tell,"[32] designers have a specific kind of knowledge, an expertise, which emerges exclusively through practice. On the one hand, a designer can use a tool without necessarily being fully aware of it and can create new things through action without specific instructions or plans for action. On the other hand, they might not know about the impact this expertise has on one's actions; for example, considering the limit in the associated application without a focused retrospection.

In addition to those very practical skills, Niklas demonstrated another noteworthy use of a social skill. This might not be based on a routine but was used rather strategically. Amidst frustration in the team, he drew upon dispute management and mediation skills briefly acquired in a school course. To maintain team motivation and productivity, he applied a combination of skills, including empathy, active listening, negotiation, flexibility, and self-regulation. Such skills proved crucial in

32 Michael Polanyi, *The Tacit Dimension,* ed. Amartya Sen (Chicago, IL: University of Chicago Press, 2009), 16.

managing team dynamics and fostering productive collaboration, especially in unknown situations that can trigger strong emotions.
Individual use of routines or strategies is contextual, responding to challenges and requirements. Design process habits involve the mostly unconscious application of tools or skills, which can be beneficial, restrictive, or even irritating when known patterns do not align with the context, as stated above. In situations where routines could not be relied upon, Niklas and Nadja remembered reacting differently. Nadja felt frustration due to unmet expectations, while Niklas, devoid of frustration and rather curious about the unexpected, sought social skills to navigate the stressful situation in the team effectively. This enabled the team to deal with the unexpected results productively.
In the following, I would like to discuss further what relevance expectations and especially unfulfilled expectations have on the design process.

Navigating expectations in design learning

The different reactions towards this unknown situation by Niklas and Nadja are based on their experiences from the past and their constituted expectations towards the future during this process.[33] As Reinhard Koselleck defines:

> *Experience is the present past, the events of which have been incorporated and can be remembered. Both rational processing and unconscious behavior, which need not or no longer be present in knowledge, come together in experience… Expectation takes place in the present, is the future made present, it aims at the not-yet, at what has not yet been experienced, at what can only be grasped. Hope and fear, desire and will, worry, but also rational analysis, receptive vision or curiosity enter into expectation by constituting it.*[34]

In the workshop, students drew on past experiences with tools and methods, forming hope about the images generated by AI and a strong will to produce great final results during this course. Based on past experiences and the presumed predictability due to some produced expected results by the AI, the rational analysis constituted their expectations. However, in the case of Nadja and Niklas, these expectations were not met. Nadja perceived unexpected results as a problem, echoing Luhmann's notion that the absence of an expected

33 For a more in-depth discussion on experience, expectations, risk and resilience see Gransche, Bruno. Vorausschauendes Denken. 1st ed. Edition panta rei. (Bielefeld, Germany: transcript Verlag, 2015).
34 Reinhart Koselleck, *Vergangene Zukunft*. 3th ed. Suhrkamp-Taschenbuch Wissenschaft 757. (Frankfurt am Main: Suhrkamp, 2020), 354–355 (translated by the author).

advantage constitutes damage.[35] By contrast, Niklas demonstrated resilience and antifragility. This not only helped him to cope with disruptions but also included the ability to benefit from these disruptions for renewal and innovative thinking.[36] During the interview, he recalled how beneficial it was to use the social skills that he previously mentioned, which made him appreciate his skills even more.

Despite gaining completely new experiences through the workshop, the students, in retrospect, still referred to phrases like 'normal design process' and 'right or wrong direction.' This suggests a persistent belief in a controllable and predictable process, hindering their perception of AI not as a controllable tool but as a tool used for a process compared to – for example – 'scribbling' to generate new ideas. Nadja's belief in "superiority over the machine" led to frustration several times during the process when her expectations were unmet.

Both students shared the goal of a favorable final outcome of this course and anticipated good grades, creating significant pressure, as revealed in the interview. This insight was crucial considering the initial motivation of this workshop. Despite offering an open and safe space for exploration, the students were still confined by their understanding of the university system's inner workings. The workshop – however open in structure – remains part of an existing education system. The university system continues to emphasize grading and assessing success, but the definition of success may vary depending on the evaluator. This dynamic poses a challenge to the intended playful exploration of unfamiliar tools, which was envisioned as an alternative to the more conventional methods of teaching design processes. Transitioning to the next section, we will explore the workshop's structure in light of the anticipated ideas and motivation of the tutors, comparing them to the experiences and memories of the students.

Workshop setup

Initially, the motivation was to provide a secure space for design students to engage openly, playfully, and curiously with unfamiliar tools and novel approaches. As previously mentioned, the workshop included different aspects such as (1) the physical space, (2) time

35 Cf. Niklas Luhmann, *Soziologie Des Risikos*. (Berlin ; New York: W. de Gruyter, 1991), 36.
36 Cf. Bruno Gransche, *Vorausschauendes Denken*. 1st ed. Edition panta rei. (Bielefeld, Germany: transcript Verlag, 2015), 221 (translated by the author).

constraints, (3) collaborative work in pairs, (4) an open workshop program, and (5) submission criteria, out of which some did not provoke the expected reaction from the students.

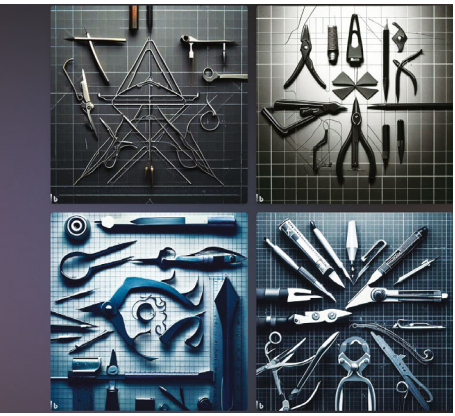
1. *Physical space:* The maker space Creapolis was chosen to break students from routine, fostering innovation and enabling a playful approach. The space should provoke new ways of thinking and working since it was not associated with other courses from the university. Notably, Nadja and Niklas remembered feeling uneasy in the maker space due to constantly seeing and being so close to the other students. While they sat opposite or next to others, they experienced a confrontation with seemingly constant production activities by their fellow students, making their own progress seem slower in comparison. However, they later found the workspace very valuable, especially during the second phase of the workshop. During the production phase, they could freely use all of the machines and tools available and fruitfully rely on their routines, which is an outstanding benefit of an open maker space.

2. *Time constraints:* The one-day workshop was aimed at preventing overthinking and adding lightness to the brief. While the strict time constraints successfully accelerated decision-making, they also resulted in pressure and frustration when results fell short, as revealed in the interviews. Niklas and Nadja recalled feelings of competition with other students, which lingered due to the limited timeframe, unlike a more extended period that would allow for putting such thoughts aside.

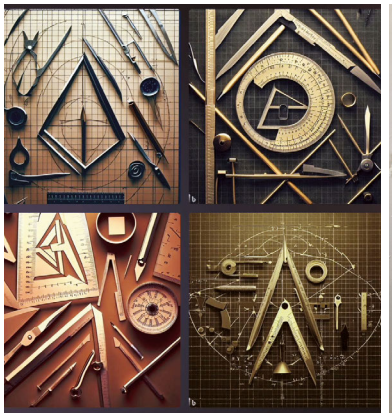
3. *Collaborative work in pairs:* The intention behind pairing students was to foster encouragement within the teams and help them discover their unique team dynamics. Decisions were meant to be a gradual outcome of discussions from various perspectives. However, working in pairs posed significant challenges for Nadja and Niklas. The decision to share a single laptop, initially considered an effective team approach, did not unfold as anticipated. Only when Niklas worked separately did they manage to refocus. Nadja initially took the lead, but she welcomed Niklas taking charge later when their expectations were not met. This letting go of team leadership provided Nadja with the external guidance she needed, as she recalls, which intentionally was not fully provided by us tutors.

4. *Workshop program:* The workshop comprised a two-phase task: generating an AI-based graphical tool image with the given programs and building/testing a prototype within the day. Intended to encourage intuition and exploration, the open approach proved challenging for Nadja, who preferred clear guidelines. The workshop's separation into phases, limited program choices (ChatGPT and Bing), and strict deadlines aimed at promoting fast decision-making. For Nadja, these constraints proved beneficial, helping her make decisions without overthinking. This underscores her struggle between needing structure and desiring exploration. By contrast, Niklas, suggested an even more open design brief during our interview, proposing that students define tasks themselves. Unusually didactic for a fourth-semester student, Niklas' ability to see potential in any process propelled the team forward during challenging moments.

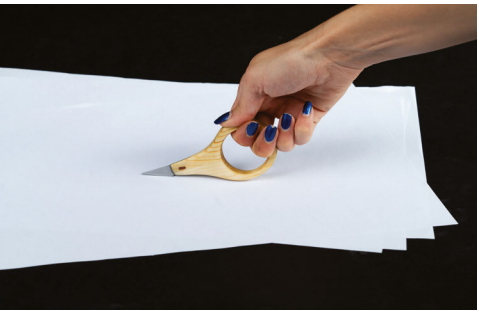
5. *Submission criteria:* The submission, encompassing the final text prompt, associated image, functioning prototype photo, prototype test graphic, and tool sketch, aimed to showcase the process to the team but also to other students and tutors. However, it also influenced Niklas' and Nadja's tool selection. Despite exploring various options initially, they ultimately chose a simpler tool due to time pressure. Running short on time in the first part of the workshop due to the mentioned challenges led them to select 'the ring' as their final graphic tool, interpreting it as a standard cutter. This choice appeared less adventurous, with their preference to stay within their comfort zone. Niklas expressed his fear, reflecting on concerns about evaluation in design studies and past experiences, influencing his decision-making towards a feasible and safe choice: "I think that in the end, there is always the evaluation … I'm trying to develop this tool, but it doesn't work. Then, in the next step, I can't implement it, and then comes the grade… and it's bad." Despite tutors emphasizing the importance of process over a perfect outcome, the fear of bad external judgment and receiving poor grades – based on past experiences with other tutors – significantly impacted their decision-making process.



The options of generated graphic tools by Nadja and Niklas.



The final results from Bing show graphic tools, including the chosen object, 'the ring,' for phase two, visible in the top-left image. The first prototype of 'the ring' was made from cardboard and metal, as seen in the image on the right.



'The ring' final prototype out of timber and metal, being tested by Nadja, was used as a standard cutter.

During the final presentation, a few weeks after the workshop, Nadja's and Niklas' tool produced unexpected results. Retrospectively they discovered unexpected potentials of the tool. For example, when using it on paper hanging vertically in space, they harnessed gravity to generate intricate graphical patterns.

The judgment of the given situation or produced outcomes is an essential part of a design process since it defines the further action of the designer. In the following, we delve into how this judgment may evolve over time.

Altering perceptions

Niklas and Nadja entered the workshop with specific expectations shaped by their prior knowledge of graphic tools. Envisioning analog tools in a grid layout, unmet expectations led them to judge alternative outcomes as 'uncontrollable,' 'not useful,' or simply 'wrong,' even in retrospection. However, a shift occurred in Niklas' perspective a few

weeks post-workshop. He found the situation challenging because the results did not turn out as imagined. Nonetheless, during the interview, he expressed enthusiasm, recognizing numerous possibilities he had not previously considered. Petra Knorr distinguishes between "recall thoughts (memorized thoughts)" and "hindsight thoughts (post-actional thoughts that arise in retrospect)."[37] Therefore, dealing with the produced outcomes proved challenging for Niklas during the workshop, but reflecting on them during the interview allowed him to identify potential value in what he initially dismissed. This change in judgment, from useless to valuable, unfolded through hindsight thoughts facilitated by the interview.

As can be seen now, the assessment of outcomes, initially tied to the students' expectations of controllability during the workshop, transformed retrospectively. Explored in-depth during the interview, this shift underscores the significance of time and reflection in altering perceptions. Furthermore, the influence of past experiences and societal factors on judgments has to be acknowledged both during and after the design process. While the workshop's pedagogical success might be debatable, the interviews prompted profound self-reflection by the students, raising crucial questions about how the higher education system fosters learning through stimulated recall and enabling retrospection in design education.

Rethinking design education for the future

Unknowability will play a prominent role in the future of design practice. Introducing new and 'intelligent' tools necessitates dealing with the unknown. In general, dealing with the unknown is not fundamentally new in design, since creating new ideas and design outcomes must have inherent unknown aspects to be called a design process. Nevertheless, when explaining a design process, this aspect is often ignored. Dealing with unknown tools, materials, processes, etc., requires specific beyond traditional ones. Educational researcher Ulf Ehlers identifies three key skill types needed in the future: subject-specific individual skills emphasizing self-organization, object-related individual skills focusing on creative development, and world/organizational skills promoting fluid and agile cultures.[38]

37 Knorr, Petra. Zur Differenzierung retrospektiver verbaler Daten: Protokolle Lauten Erinnerns erheben, verstehen und analysieren, 39.

38 Cf. Ulf Ehlers, "Future Skills Und Hochschulbildung" 75 (December 31, 2019), 42.

These essential skills are often absent in current curricula, but – as highlighted through this workshop and retrospection – a stronger focus on those skills is required. Design education must proactively equip students for evolving demands, encouraging critical reflection regularly. Curricula and tutors should cultivate these skills and offer a safe learning environment, which is not always given in the competitive field of design. Many design tutors mistakenly believe these skills are taught incidentally. This research addresses this oversight in design education today.

Acknowledging limitations, this text focuses on a single team of students during the described workshop. Broader analysis involving multiple teams, semesters, universities, and tutor influence could provide deeper insights. No general conclusion should be drawn from the students' experiences in one workshop, but observations point to potential gaps in the design education system.

To conclude, design education must recognize the significance of open-ended processes, self-directed learning, and guided retrospection alongside traditional teaching. Competencies like self-efficacy, critical reflection, and decision-making are crucial for future success but are often neglected in design curricula or incomprehensibly taken for granted. Guided reflection, such as post-workshop interviews, fosters critical thinking. Considering students' ability to reflect on creative practice helps identify missing and existing skills and fosters future transformation. Combining formats of practical creation and in-depth reflection enables students to recognize conflicts, discover potential in discarded outcomes, and gain experience in handling the unknown. A stronger focus on training students in those skills and providing space for retrospection prepares them when facing challenges in an unknown future work environment.

Throughout this workshop, students encountered the unknown in various forms, as unknown tools, results, or actions. Design education should support students in developing future skills, gaining experience, and guided reflection, avoiding imposing 'right' and 'wrong,' 'good' and 'bad' design results. This transformative approach encourages meta-level reflection, cultivating trust in students' ability to handle unknown tools and navigate unfamiliar situations.

Zahra M.Ganjee

Dionysian Tendencies in Design
How references work in complex situations

Complexity

In the 1980s and 1990s, ordinary people in Iran frequently used a phrase, initially to encourage collective efforts in the face of wartime conditions and later to blame the unsuccessful projects in the post-war period. The phrase was: "We exhibit greater creativity in the midst of complexity." What people wanted to refer to was their general understanding of the relationship that they found between complexity and creativity. By 'complexity,' they meant situations with properties, behaviors, or patterns that are not directly predictable from the properties of their individual components. This was the case because the number of interacting components of every situation had dramatically increased during the war. The mental and psychological states of individuals – including people and soldiers, societal responses to incidents, domestic policies, developments on the war front, economic conditions, the policies of foreign nations, and numerous other variables – were added to a complex combination of existing factors, and changes in each of these variables had direct or indirect and sometimes disproportionately large effects on many other domains. As a result, the possibilities of unpredictable behavior and uncontrollable results in each project were increased. Therefore, even the problem figure was not very descriptive. The dimensions and characteristics of the problem could change at every moment, and it could create a more ambiguous face. Consequently, it

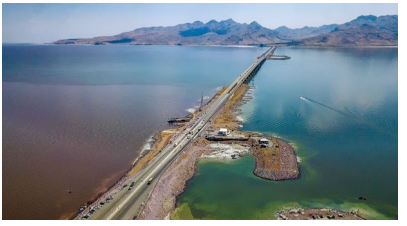
could not be framed or defined easily. And, by creativity, they meant a kind of fearless action that goes beyond the closed scope of norms and past solutions. To clarify the term 'creativity,' I refer here to Robert Franken, who defines it as a tendency to generate or recognize ideas, alternatives, or possibilities that could be useful in solving problems ... an ability to generate alternatives or to see things uniquely, which is linked to fundamental qualities of thinking, such as flexibility, tolerance of ambiguity or unpredictability, and the enjoyment of things heretofore unknown.[1]

In order to better explain the root of forming the above phrase, I compare two challenging projects which were both related to bridge construction; one of them was a project of providing a passageway to transport heavy military equipment, drinking water, and food from one side of the Arvand river to the other side in the heart of the battle in the 1980s. The other is related to the 1990s when the war was over, and connecting two sides of Lake Urmia in the west of Iran was needed to facilitate traveling between two cities. Due to intricate hydrological and environmental factors, geological conditions, and structural engineering challenges, bridge construction on a river is itself a complex problem. The war conditions impose a double challenge. The main difference in how people faced complex problems during and after the war was that, in the 1980s, there were still those who, like their ancestors, knew how to interact with the unknown and were not afraid of facing ambiguous and wicked problems. However, in the 1990s, the number of university graduates significantly multiplied,[2] and the prevailing belief in science as the sole credible authority for knowing and engaging with the world discredited reliance on other kinds of knowledges. Therefore, they increasingly leaned towards relying on scientific frameworks and university research results. They often sought paths that appeared scientifically secure and navigable and could provide tried-and-tested solutions to similar problems. With facilitated global communication, access to many of these solutions and ongoing projects – which served as a source of inspiration for addressing myriad post-war issues – became available. Nevertheless, there was always the possibility that these solutions might not be suitable for new conditions.

1 Robert E. Franken, *Human Motivation.* (Thomson Brooks/Cole, 1994), 396.
2 According to the statistics of the Ministry of Science, the rate of university education in Iran was twice as high in the 1990s as in the 1980s.

The river in the first example stands out from most rivers worldwide due to its unique behavior, experiencing two high tides and two low tides daily, resulting in a 3-meter water level fluctuation. Additionally, the water speeds of up to 70 kilometers per hour, irregular whirlpools, and a 900-meter width contribute to its wild and turbulent nature. Consequently, constructing a temporary wartime bridge over a river with unpredictable behavior posed many challenges. The process of building the bridge should remain hidden. It was not possible to carry heavy and huge equipment to the bridge site. The bridge's parts had to be assembled on-site with minimal facilities. The bridge must survive against tides, water pressure, and eddies. In typical wartime scenarios, temporary bridges over calm waters utilize floats or shallow-draft boats to support a continuous deck for pedestrian and vehicle travel. However, the conditions of the Arvand River made this type of bridge unfeasible. Nevertheless, over three years, multiple successful models of temporary bridges were constructed, each tailored to the specific circumstances.[3] The bridges were built by those who did not necessarily have an engineering education in a related field of study, but they knew how to interact with the ambiguity and complexity of the project, the unpredictable behavior of the river, and the existing challenging conditions. It can be said that for them scientific research and science in its academic sense was a side-issue. Essentially, the complexity and variability of conditions prevented them from scientifically testing soil, water, and other variables. As a result, the scientific approach was not welcomed from the beginning. Instead, they seem to have adopted "a model of dealing with the world that is not dependent on science."[4]

situation of Urmia Lake in 2023



Urmia Lake Bridge

3 Unfortunately, photos of the bridges are difficult to access, probably due to military reasons.

4 Andrew Pickering, "Acting with the World: Doing without Science." E-Cadernos CES, no. 38 (2022). accessed April 01, 2024, https://journals.openedition.org/eces/7894
"Science is part of the problem, and it is at most a side-issue in the poetic projects I've examined. It interests me a lot that there is a pattern of acting with the world that does not hinge on science and that is presently overshadowed by science. Part of my project is to foreground this strange pattern of 'doing without science.'"

The conditions of Lake Urmia, in the second example, were also very challenging compared to the other similar lakes due to the social, cultural and historical importance of this lake, geographical, and geological features and even the water's chemicals.[5] However, during the 1990s, despite the facilities and the removal of restrictions, and despite the fact that all of those involved in the project had academic education in the field of engineering and bridge construction design, and proceeded with scientific studies and experiments, the Urmia Lake Bridge became a failed project with many consequences for the environment and local residents. Therefore, people had come to believe that engineers' and designers' hands and minds were tied more tightly during this period. No traces of interaction with the ambiguity of the environment and complexity of the problem can be seen in this project. Instead a narrow focus on previous solutions resulted in building a typical bridge of the Tied-Arch type with very harsh consequences that many argue the bridge should be demolished as soon as possible. The effects of this decision include severe water blockages, the division of incoming water into two basins, and increased evaporation rates. This bridge has ultimately become a significant contributor to the environmental crisis in the region. Consequently, nearby cities now face the threat of salt storms, and the destruction of the lake's ecosystem looms on the horizon. As it was aptly stated, if, in the old science, it was possible to go into the laboratory, shut the door, and exclude the universe outside from consideration, the science of complex systems is not like this since it is not possible to separate their social and physical subsystems and study them in isolation. More generally, the subsystems of complex systems cannot be studied in isolation.[6] Complex systems often involve non-linear relationships, where small changes in one part of the system can lead to disproportionately large effects elsewhere. Therefore, seemingly minor decisions can have significant consequences. This feature is also seen in design. Brayan Lawson explains the complexity of design and states:

5 The lake's width at the place designated for the bridge was 1,270 meters. The lake's bed – up to a depth of more than 40 meters – comprises a mass of sludge with special compounds, which lacks the necessary resistance for loading. The amount of salt in water is at saturation level. It is the sixth-largest saltwater lake on Earth, and the water's chemicals make the bridge's construction and durability more difficult.

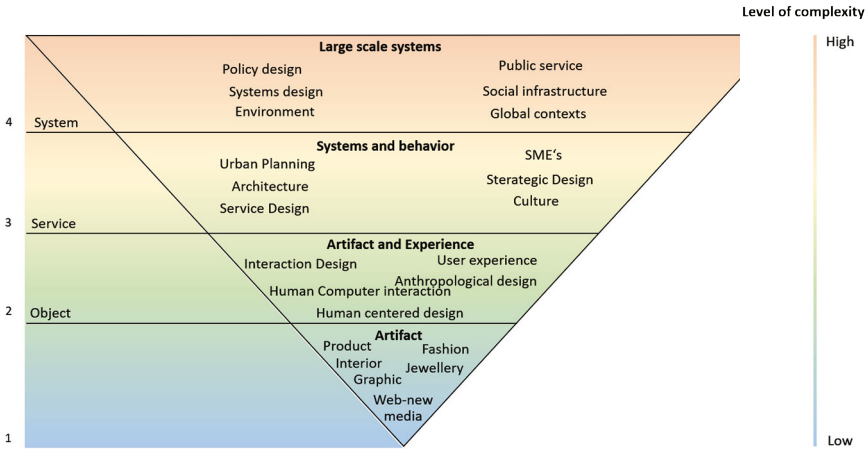
6 Katerina Alexiou, Jeffrey Johnson, and Theodore Zamenopoulos. *Embracing Complexity in Design,* (Routledge, 2009), 193.

> *Designers must be able to recognize and understand not just existing situations but ones that might exist if the design were to be constructed. In effect this means that a designer is potentially in some infinitely regressive world that shifts each time a change is made to the design.*[7]

Complexity is an essential feature of designing.[8] In other words, it inherently derives from the nature of the design. In the realm of design, we navigate through various domains, each with its unique set of attributes. Our decisions and actions have far-reaching implications that extend beyond a single domain. In fact, in the most extreme scenarios, a choice rooted in the intentions of one domain can ripple across all other interconnected domains, triggering a cascade of effects that reverberate throughout the entire design process. This interconnectedness underscores the intricate nature of design, where our choices are multi-dimensional and have consequences in all other domains.[9] Even if designers were able to define the problem considering all of the consequences and qualities across every domain, solving it would have appeared incredibly complex. This challenge is similar to finding a way through a vast and dense forest, where complexity and ambiguity abounds. At the time of beginning a project of any size, designers will usually feel overwhelmed by the amount of material they have to cover and dealing with the mass of ideas in their head. "However, wandering through that forest is an essential stage in any creative endeavor."[10]

Herbert Simon explains that "pure" science is the study of systems as they are, e.g. astronomy or the collection of biological specimens. By contrast, the science of complex socio-technical systems is usually concerned with systems as they ought to be.[11] The expansion of design thinking to other fields, such as management and sociology, has caused design to evolve into more complex environments. Obviously, the level of complexity in each design practice is different depending on the conditions of each project. Furthermore in general, different fields of design can be categorized based on the extent and complexity. The following table includes the design of tangible artifacts to the design of intangible ones and

7 Bryan Lawson, *What Designers Know,* (Routledge, 2012), 117.
8 Schön, D.A. "Designing as Reflective Conversation with the Materials of a Design Situation." Knowledge-Based Systems 5, no. 1 (March 1992): 3–14. https://doi.org/10.1016/0950-7051(92)90020-g.
9 Ibid.
10 Alec Nevala-Lee. "Surviving the German Forest,"accessed August 27, 2024. https://nevalalee.wordpress.com/2015/08/27/surviving-the-german-forest.
11 Herbert Alexander Simon, *The Sciences of the Artificial.* (MIT Press (MA), 1969).



Sub-disciplines of design practice operating on different levels of complexity, Table re-drawn from https://ithinkidesign.wordpress.com/wp-content/uploads/2014/07/typology-of-dt-inverted.jpg

from traditional design practice to the influence of design thinking in fields outside of design practice.[12]

"Complexity by itself is neither good nor bad: it is confusion that is bad."[13] Walking amidst a dense forest where, at first glance, all trees appear similar can be disorienting and dizzying. Time is needed for the paths among the trees to reveal themselves. "Complex things become simple after we have mastered them, after we understand how they operate and the rules for interaction."[14] Various researchers have proposed different methods to facilitate complexity in design. This article refers to three approaches: the transformation designer's co-evolutionary approach, Andrew Pickering's doing-without-science approach, and Donald Schön's interactive approach. Each one of their methods, assists designers in dealing with ambiguity, unpredictability and unknowns in complex situations. Once we understand the rules for dealing with complex situations, they become manageable and subject to communication. In all these methods, due to the impossibility of acquiring sufficient knowledge in all required areas, we are unable to consider all the potential consequences. Therefore, designers are compelled to initiate work on the project from a simple idea in a smaller domain, which Jane Darke calls it the "primary generator."[15] However, they can allow considerations from

12 Stefanie Di Russo, Understanding the Behaviour of Design Thinking in Complex Environments. Melbourne: Unpublished PhD thesis. (Melbourne: Swinburne University, 2016), 42.
13 Donald A. Norman, *Living with Complexity.* (MIT Press, 2016), 4.
14 Ibid. 222.
15 Jane Darke, "The Primary Generator and the Design Process." Design Studies 1, no. 1 (July 1979): 36–44, accessed April 15, 2024, https://doi.org/10.1016/0142-694x(79)90027-9

other domains to seep in gradually. This way, they uncover some unintended consequences of their actions during the work process. Since the process of design education cannot escape from explaining the first step in design, and design practice is tied to this step, and the primary generator directly impacts the entire design practice; it is essential to know what the primary generator can be. How can we achieve it, and what approach can lead designers to a more creative and satisfactory solution? The primary generator in design can be an idea taken from a topic outside the project, which may seem unrelated but familiar to the designer (reference), or an utterly related idea drawn from past solutions (precedent). In the following, I will provide a brief explanation for both. Despite acknowledging the differences between these two, many researchers in the field of design mistakenly use precedent for both of them. Whereas the term 'precedent' is less satisfactory than 'reference' as a generic description of this phenomenon in design. Goldschmidt prefers to see precedents as a subclass of the more general idea of reference.[16] Here we examine these two concepts independently and in relation to the concept of complexity and not knowing. Therefore, it remains faithful to their respective definitions and does not place either of them as a subset of the other.

Precedents

Kees Dorst and Nigel Cross discuss how a problem-solution pair is framed by designers, defining the design situation by considering the insight that a possible solution can provide. Such possible solutions are drawn from, or suggested by, the designer's storage of precedent knowledge.[17] According to Cross, design knowledge resides in designers and products in addition to the design process. Taking the first step based on the existing solutions or similar examples of a specific product, is the method generally followed by many designers. Cross elucidates that "much everyday design work entails the use of precedents or previous exemplars - not because of laziness by the designer but because the exemplars actually contain knowledge of what the product should be."[18] Put differently, they contain existing solutions. Precedent knowledge is a form of knowledge specific to the

16 Lawson, What Designers Know. 96.
17 Jason K. McDonald, and Richard E. West, *Design for Learning,* (2021), 5.4.4.
18 Ralf Michel, Design Research Now. (Walter de Gruyter, 2012), 47.

activities and goals of design, and you do have some, whether you realize it consciously or not. This kind of knowledge is also called episodic knowledge. Within the mind of each designer, precedent knowledge is structured over time into multiple schemata: "precedent stored in the form of episodic schemata is used by experts to recognize design situations for which gambits are available."[19] Lawson does not suggest that precedent knowledge should be turned into abstract knowledge through the creation of generalized principles. Instead, he explores schemata as patterns where the original experiential elements remain unchanged, serving as potential design actions that can be considered applicable to the current design context.

Many designed buildings, services, and products around us, from the simplest to the most complex, have preserved the legacy of their design. That is why we usually see not so many changes. For instance, the first typewriters were built in the early-1870s. Their (QWERTY) keyboard layout is still widely used today. It is not necessarily the most efficient or ergonomic keyboard layout for today's digital devices. Nonetheless, the widespread adaption of the QWERTY layout has been challenging to change due to its wide range of use and acceptance. Although Cross suggests that using precedents is not due to a designer's laziness, the reality is that, in practice, precedents are catalysts that expedite the design process and assist in bringing ideas and finding a more straightforward path to a solution. Precedents are often either whole or partial pieces of designs that the designer is aware of. They may be previously employed solutions by the same designer or other designers.[20] In the forest metaphor, precedents are like a path, a trampelpfad, constructed over time, allowing for a swift passage through the forest. Precedents usually play a crucial role in design education. In architecture education, building precedent knowledge has long been a highly structured activity, overtly and rigorously pursued by means of memorization.[21] In studio projects, students are expected to be able to identify precedents and analogies with their work, as a way to explain and justify it.[22]

19 Lawson, What Designers Know, 1.
20 Ibid. 96.
21 Bryan Lawson, *The Design Student's Journey.* (Routledge, 2018).
22 Eastman, Charles. "New Directions in Design Cognition: Studies of Representation and Recall ." Design Knowing and Learning: Cognition in Design Education, 2001, 147–98. https://www.researchgate.net/profile/Charles-Eastman/publication/246935473_New_Directions_in_Design_Cognition_Studies_of_Representation_and_Recall/links/54186d520cf2218008bf3ca0/New-Directions-in-Design-Cognition-Studies-of-Representation-and-Recall.pdf

Lawson recounts his time as an architecture student at the University of Oxford, where students were required to draw the designs of many famous historical buildings from memory.[23] A similar practice exists in product design, where students are encouraged to study and remember notable examples from renowned designers. Furthermore, each defined project commonly commences with a strong recommendation to research the precedents related to the problem and study existing solutions. As a student at the Faculty of Design at Sapienza University, benchmarking was necessary in the early stages of every design project. Through benchmarking, students were asked to find the best practices, creativity, and innovation in the field. The result should then be used as a starting point and source of inspiration for the students.

Alongside its general meaning, the term precedent is commonly associated with its usage in the legal system. Extensive databases are available in the offices of all lawyers, and they are required to search for specific aspects of past cases to find potentially similar ones that can be used as legal precedents. By referring to the database of legal precedents in every country, some parts of the judicial decision-making processes can be delegated to artificial intelligence. Artificial intelligence can identify cases from the existing files with relatively similar conditions and, based on them, offer counsel, suggestions, and predictions. Doing so can streamline the judgment process, mitigating many instances of human error or biased viewpoints. A similar system exists for design, aided by machines, which is commonly employed today to expedite the design process, simplify the path for more complex projects, or reduce the cost of the process. Precedents in design and architecture have played a significant role in automating the design process. These precedents assist machines by enabling them to access design principles, aesthetics, and user preferences through analyzing and aggregating successful and influential designs. Artificial intelligence possesses data banks consisting of design precedents, which can generate new designs in user-preferred styles or provide design recommendations based on design precedents. For instance, in web design, it can propose layouts, color schemes, and typography choices by referring to successful websites with similar content or objectives. One of the best

23 Ibid. 101.

and most accessible examples in this regard is the platforms that assist graphic designers; for instance, Hatchful, Smashing Logo, and Looka are some of the many logo generator tools out there. They provide a wide range of logo templates categorized by industry and style. Clients[24] can customize these templates to create their desired logos while drawing inspiration from the provided designs.

Analyzing design precedents even helps artificial intelligence predict future design trends. By understanding designs that have gained popularity in the past, artificial intelligence can steer towards future design trends and incorporate these trends into new designs. It can also personalize designs based on individual preferences. Regardless of benefiting from precedents in enhancing artificial intelligence capabilities in the design process, the role of precedents in design compared to precedents in the legal system is entirely different. Each design process is defined with the goal of making even a minor change. It is yet expected to update and improve old solutions constantly. Wolfgang Jonas views this as an imperative and states: "Design must consciously generate variations and create differences, because the 'fits' dissolve, disappear, and become outdated" (translation by author).[25] Besides, Lawson believes that the nature of the design is such that "no two design situations are ever identical."[26] In other words, all design problems are unique. Therefore, unlike the lawyer, the designer is not aiming to showcase a direct match with the precedent; instead, they are leveraging something that shares sufficient similarity in certain aspects to serve as a valuable starting point.[27] In addition, while it is true that drawing inspiration from successful design works can provide valuable insights and create positive impressions, it is equally essential to uphold the intrinsic value of originality and uniqueness in the design process. Among the other points that designers should consider when relying on precedents is that they are whole or partial solutions. Accordingly, they demonstrate possible ways of doing things in design.[28] In fact, being precedent-focused in reaching a solution – much like being solution-focused – is seen in contrast to being problem-focused. The

24 Here, the presence of a human designer is no longer necessary.
25 Wolfgang Jonas, *Mind the Gap! - Über Wissen Und Nichtwissen Im Design,* (2006), 47.
Design muss bewusst Variationen herstellen, Differenzen schaffen, weil die „Passungen" sich auflösen, verschwinden, altmodisch werden."
26 Lawson, What Designers Know, 96.
27 Ibid. 96.
28 Ibid. 98.

term solution-based precedent goes back to when designers and architects used pattern books. Lawson describes the use of patterns book and its relation to the solution and problem as follows: "If the pattern of the problems could only be seen as it is and not as the bromide image of a previous solution conveniently at hand in the catalog or magazine around the corner." He continues with this explanation: "stop being solution-focused and become problem-focused!" Using precedents in the first steps of the design process means starting with the previous solutions, which in a complex system limits the domains of creativity from the first point. Staying within the realm of tried-and-tested solutions keeps us away from exploring new horizons. While focusing on the problem at the beginning of the design process means focusing on the context from which the solution is expected to emerge. Here, according to Alexander, "form is the solution to the problem; the Context defines the problem."[29] He explains in his book "Notes on the Synthesis of Form" that the designer never really understands the context fully. He may know piecemeal what the context demands of the form, although he does not see the context as a single pattern – a unitary field of forces.[30] Furthermore, since the context is so vast and each person understands only a part of it, each solution will necessarily have a personal flavor, so we may have different solutions based on the number of designers because it is unclear from the perspective of each designer which part of the context is considered a problem and which part needs attention.

References

In contrast to designers who place emphasis on precedent, the second category includes those who initially look to references. References draw upon the designer's own knowledge and experiences, which are not necessarily related to the context but could also include "personal precedents."[31] According to Cross, "design knowledge resides firstly in people: in designers especially."[32] On this basis, it can be said that Cross also believed that the designer's knowledge holds greater importance than product knowledge. Socrates

29 Christopher Alexander, *Notes on the Synthesis of Form.* (Harvard University Press, 1964), 15.
30 Ibid. 90.
31 What I mean by "personal precedents" is the precedents that the designer probably created in previous projects.
32 Michel, *Design Research Now,* 47.

expressed in Theaetetus that although always regarded as the most direct way, it is not the nearest way but a meandering and twisted path that the journey of knowledge takes. While using precedents is seen as a shortcut, choosing references over precedents means opting for a longer, more twisted path. References explore the vast unknown, while precedents stick to the well-marked roads. References reflect a designer's personal experience, whereas precedents are the experiences of others, which we only have a general understanding of, making them impossible to fully grasp. Elizabeth Boling, who also works on precedents and references, argues that "each designer's store of experiences is unique to that designer. Even when multiple designers share the same experiences, they do not necessarily pay attention to the same aspects of those experiences, or recall them later in the same way."[33] However, professional designers delve not only into solutions but also into meaning, and for this purpose, they turn to references beyond the scope of the subject. For instance, although there is no clear connection between a squid and a lemon squeezer, it is said that the design reference for the lemon squeezer of Philippe Starck was a calamari squid plate at a restaurant. Alberto Alessi, president of the Italian design company of the same name, explained the way he received the sketches and said;

> *I received a napkin from Starck, on it among some incomprehensible marks (tomato sauce, in all likelihood) there were some sketches. Sketches of squid. They started on the left, and as they worked their way over to the right, they took on the unmistakable shape of what was to become the juicy salif. While eating a dish of squid and squeezing a lemon over it, Starck drew on the napkin his famous lemon squeezer.*[34]

The napkin with sketches by Starck, Reference: https://hivemodern.com/pages/product36/juicy-salif-juicer-starck-alessi.

33 McDonald and West. Design for Learning, 5.4.1.
34 hivemodern.com. "Juicy Salif by Philippe Starck for Alessi | Hive, accessed " June 10, 2024, https://hivemodern.com/pages/product36/juicy-salif-juicer-starck-alessi

Lawson asks: “Why can some designers sometimes draw on references from apparently remote situations and use them in quite novel ways that not only surprise us but also seem entirely relevant to us?” Then he answers: “Perhaps this is at the very heart of what we mean by creative production.” There are many such examples. Due to their deep cultural familiarity with a concept, certain designers can excel in advocating for entirely unrelated ideas. For instance, consider miniaturized robots that draw inspiration from origami. These robots possess the capability to autonomously transform into intricate 3D structures by leveraging origami principles adjusting their folding and unfolding techniques to match various tasks at hand. The folding patterns dictate the robot’s functionalities; otherwise, a plain sheet would remain stationary. Typically, these origami-inspired mini-robots are crafted by individuals who have cultivated their understanding of this art or originate in cultures that place a strong emphasis on origami, like Japanese and Chinese traditions.

Self folding origami robots, Photo credit: CSAIL, Reference: https://danielarus.csail.mit.edu/index.php/2015/09/lorem-ipsum-2/

Design knowledge and using references

This property, which involves drawing references from an experience, memory, or an emotional or mental state, can indeed make the process of shaping a potential solution ambiguous and complex. It means that many qualities and dimensions of the final product, including materials, plans, colors, form, dimensions, functionality, internal and external relationships, environmental impacts, cultural, social, and other potential influences, may remain obscure. This feature often leads only professional designers to dare to use references as primary generators. Novice designers and design students often face challenges when using reference as the primary generator. It is not easy to visualize ideas that have not been realized before.

They are imaginary pictures that manifest themselves vaguely in the designer's mind. To have a clearer shot, one must reduce the density of fog. They must learn how to transform a vague mental image or a memory into a tangible product or service. However, design education systems usually prefer to use more concrete methods like utilizing precedents instead of finding ways to convey and reflect abstract concepts such as intuition and imagination in the design process, which are difficult to express and convey. Therefore, due to the ambiguity present in this approach, education needs to redefine theoretical and practical methods for students.

For this purpose, strengthening non-formal intelligence will assist designers. Techniques at this level are typically taught by generalizing examples and are pursued intuitively without resorting to rules. According to Hubert Dreyfus's classification of intelligent activities,[35] design knowledge[36] is included in the category of non-formal behavior (Area IV), which emerges in an undefined and shifting set of situations. The area of non-formal behavior encompasses "all those everyday activities in our human world which are regular but not rule-governed."[37] Besides design, games in which the rules are not definite – such as guessing riddles and disambiguation of natural languages – are also included. To explain the characteristics of this group, Dreyfus says:

> *Area IV differs from Area III (which is called complex formal behavior) simply by introducing a further level of complexity, whereas Area IV is of an entirely different order than Area III. Far from being more complex, it is really more primitive, being evolutionarily, ontogenetically, and phenomenologically prior to mathematics.*[38]

Non-formal intelligent behavior helps designers not only to visually register information but also to form its meaning or, as Schön states it, they identify patterns and give them meanings beyond themselves.[39] Pattern recognition in this domain is based on the recognition of the generic or typical knowledge and the number of

35 According to Hubert Dreyfus, classification of intelligent activities are Area (I) Associationistic, Area (II) Simple Formal, Area (III) Complex Formal, and Area (IV) Nonformal.

36 Different names and descriptions have been attributed to the knowledge of design, such as intuitive knowledge, practical knowledge, or tacit knowledge. The distinguishing feature of design knowledge is that the type of reasoning and dealing with phenomena in design differs from the type of reasoning in other sciences, such as mathematics, philosophy, or physics.

37 Hubert L. Dreyfus, *What Computers Still Can't Do.* (MIT Press, 1992), 206.

38 Ibid. 206.

39 Schön, "Designing as Reflective Conversation with the Materials of a Design Situation." 3–14.

individual experiences. Problems on this level are open-structured, requiring determining what is relevant and insight into which operations are essential before the problem can be attacked. Techniques on this level are usually taught by generalizing from examples and are followed intuitively without appeal to rules.[40] In fact, "some essential knowledge needed to perform the task lies outside the problem itself but in knowledge of situations in which the problem may arise."[41] For instance, focus on meaningfully translating the homonyms in the following sentences.

Stone is under the nail.
The match did not work.
Box is in the pen.
Someone is in the bark.

In understanding the meaning of such phrases, human intelligence seeks clues within and beyond the text. To understand the sentence "box is in the pen," we need information outside the sentence itself. For instance, we need information about the pen size compared to the box. This is something that is not explained within the sentence. Therefore, it explores a contextual interpretation of pen that can accommodate the box. Our past experiences come into play to help us comprehend the contextual meaning. In English, pen has the following two meanings: a certain writing utensil and an enclosure where small children can play. Here, our information about the children's playground and its size is also helpful. Therefore, instead of a writing instrument, we refer to a playpen that can hold a toy box. Design knowledge typically aligns in a similar manner in this situation. This means that the information needed to arrive at an interpretation for any given problem lies outside of that problem itself. Essentially, "design solutions have a rather curious and complex relationship with design problems."[42] References also invite the designer to contemplate a broader spectrum of possibilities. Goldschmidt elaborates on this point by comparing it to precedents:

40 Dreyfus, What Computers Still Can't Do, 206.
41 Lawson, What Designers Know, 117.
42 Ibid. 8.

> *Research on analogy distinguishes between within-domain source analogs and between-domain ones, and it is generally believed that good between-domains source analogs are potentially more potent aids in creative problem-solving ... Likewise, we believe that precedents, which are within-domain visual design aids, maybe less powerful triggers for creative designing than are other between-domain forms and images that designers can read off various.*[43]

As an example, Goldschmidt points to architecture and explains that precedents in architecture only include buildings, and this means limiting ourselves to within-domain sources, which are a restricted source of stimulants. However, referring to images and objects other than buildings and unrelated experiences to the buildings (between-domain sources) evokes more creative ideas for an architect. Each design project beckons the designer to meditative thinking. This helps to discern subtle relations and patterns that are not easily readable. Calculative thinking should be avoided, especially in the early stages of any design process. With their relatively ambiguous and unknown nature, references cannot be obtained by calculative thinking. As "calculative thinking is not meditative thinking, not thinking which contemplates the meaning which reigns in everything that is."[44] By contrast, "meditative thinking demands of us that we engage ourselves with what at first sight does not go together at all."[45] There are no constraints for something to merit being a reference, except that it evokes an implicit meaningful connection for the designer, a connection that relates to their project in a way only they can understand. For instance, although, many viewed it as a shard of glass nestled in the heart of London, the connection that Renzo Piano saw between the design idea of the Shard Tower and the city of London was based on his repeated experience of observing tall-masted ships on the Thames. Goldschmidt states: "To be valuable, a reference must carry meaning and a designer must therefore have sufficient intimacy with it. It also has to relate to concerns that are on a designer's agenda, which may undergo frequent changes. Collections of references are therefore a rather personal matter."[46] References are typically simple clues that seem to come to the designer's mind almost accidentally but are, in fact, connections forged through the designer's experiences with

43 Goldschmidt, Gabriela. "CREATIVE ARCHITECTURAL DESIGN: REFERENCE VERSUS PRECEDENCE." Journal of Architectural and Planning Research 15, no. 3 (1998): 258–270. http://www.jstor.org/stable/43030466

44 Martin Heidegger, *Discourse on Thinking,* (1966), 46.

45 Ibid. 53.

46 Goldschmidt, "CREATIVE ARCHITECTURAL DESIGN," 258–270.

meaningful ties to the project. This very openness of the nature of references – coupled with their inherent ambiguity – places them among experiences that seem elusive, occasionally reminding us of them.
References can be derived from a vague image of a memory, a natural phenomenon, a fantasy, or a seemingly related or unrelated imaginary scene. It means, even a designer's imagination can be used as a reference. John Zeisel argues that one of the key features of the design process is working with heuristic information. He sees this type of information as a catalyst for imagination.[47] Philipp Oswalt also considers the logic followed by design as a different, imagination-based logic. According to him, this is the very reason why not knowing plays a productive role in it.[48] Based on this, the greater challenge in designing is letting go of accumulated knowledge. He abandons classified information and scientific logic and, for solving a complex, multi-layered problem, relies on non-formal problem-solving intelligence. Non-formal intelligence helps designers picture new and unfamiliar patterns and imagine meanings beyond what scientific reasoning suggests. In sciences such as mathematics, philosophy or physics, we usually deal with inductive and deductive reasoning. While the type of reasoning and dealing with phenomena in design is different. Lionel March considers abductive thinking as the key element of design reasoning, although his preferred name for this type of reasoning for design knowledge is productive reasoning. This type of reasoning is also called intuitive. Some, like John Kolko, introduce abductive reasoning as the 'best guess' leaps;[49] others consider it envisioning and anticipation. According to Kolko's definition, abduction is "the hypothesis that makes the most sense given observed phenomenon or data and based on prior experience."[50] Therefore, the richness of the designer's experiences can facilitate abductive thinking. Charles Sanders Peirce articulates abduction as "that type of argument that starts from a surprising experience, that is, from an experience that contradicts an active or passive belief. This takes the form of a perceptual judgment or a proposition relating to such a judgment,

47 John Zeisel, *Inquiry by Design*. (CUP Archive, 1984), 6.
48 Haare Hören - Strukturen Wissen - Räume Agieren, 2015 , 150.
49 Jon Kolko, "Abductive Thinking and Sensemaking: The Drivers of Design Synthesis." Design Issues 26, no. 1 (January 2010): 15–28. https://doi.org/10.1162/desi.2010.26.1.15.
It is also called "intelligent guessing" by some others.
50 Ibid. 15–28.

and a new form of belief becomes necessary to generalize the experience."[51] According to most empirical findings, intuition is also based on a large amount of practice and accumulative experience.[52] The connection between references and abductive-intuitive reasoning is interesting. Both using references and abductive-intuitive thinking are dependent on experience, and both operate without dependence on rational reasoning. Intuition is also described as the apprehension of an object by the mind without the intervention of any reasoning process.[53] The same is true for reaching a reference. Any phenomenon can be a reference without any logical connection. In design practice, finding a reference is generally intuitive, at the core of abductive reasoning. Relying on references can be seen as turning to Dionysian tendencies instead of Apollonian tendencies. They are not like precedents to be archived or stored in databases. Essentially, they operate outside the realm of rules and are independent of any formula or theories. Furthermore, they are typically not easily formalizable, explained, or shared. Intuitive and abductive reasoning are essential tools of the design practice to create references as primary generators. Abductive thinking "is particularly evident at early design stages when synthesis must be carried out with only intangible intents and incomplete information."[54] In a study about the behavior of designers in complex environments, the researcher explains that:

> *Abductive reasoning proved to be a major force behind the navigation around complex and ambiguous project briefs... The complex, ambiguous project brief significantly influenced the attitude, mindset and approach that both design teams took towards the design process. Intuitive and abductive reasoning was observed as a fundamental driver for both design teams when faced with complex and ambiguous environments.*[55]

Even where user-centered design has been prioritized, this research shows that designers rely more on intuition, especially in unknown, ill-determined, and ambiguous conditions. "Where there was a crossroad between relying on user feedback or intuition to fill in for gaps in knowledge, the design teams often chose

51 Charles Sanders Peirce, Philosophical Writings of Peirce, (1955). http://books.google.ie/books?id=YHjcAQAACAAJ&dq=Philosophical+writings+of+Peirce&hl=&cd=2&source=gbs_api
52 Trent Ling, Y. G. Xiao and Petra Badke-Schaub. "HOW INTUITION AFFECTS DESIGNERS' DECISION MAKING: AN INTERVIEW STUDY." (2014). https://www.designsociety.org/download-publication/35199/how_intuition_affects_designers%E2%80%99_decision_making_an_interview_study
53 Ibid.
54 Lu, Stephen C.-Y., and Ang Liu. "Abductive Reasoning for Design Synthesis." CIRP Annals 61, no. 1 (2012): 143–46, accessed April 15, 2024, https://doi.org/10.1016/j.cirp.2012.03.062.
55 Di Russo, *Understanding the Behaviour of Design*, 113.

to trust their own ideas and instincts. Designers 'filled in' for missing information using intuition and gut instinct."[56] On the other hand, precedents are chosen quite logically. Using precedents as primary generators puts the design train on a pre-set rail from the beginning and makes the subsequent movements not limited but faithful to the precedents. Essentially, using precedents means continuing the path that has been taken up to that moment and showing the direction of movement in the future. This is while complex situations are generally in a constant flux of transformation. Therefore, it is better not to build a strong foundation for a primary generator and not to make a concrete and clear idea. "Attempts to frame a problem solution early in the process could not adequately account for all of the necessary number of variables that would impact the project."[57] The primary generators can be completely unrelated, unclear, unknown, and unimaginable, and just like a floating shapeless piece of wood detached from a tree, constantly changing direction with the flow of water, forms a shape by joining and separating other pieces. These pieces are the same as references that help designers in the first steps, when no horizon can be seen in the distance, and the problem is still ambiguous and unknown. The designer gives the pieces of the unformed idea into the design flow and cautiously tries to keep up with the unknown currents.

Not knowing and dealing with complexity

Science usually uses precedents. As in other areas of inquiry, science (through the scientific method) can build on previous knowledge and develop a more sophisticated understanding of its topics of study over time. Although it is very likely that references also help scientists, usually, most of the scientific progress is based on previous results. German sociologist Dirk Baecker refers to the book Die Fabrikation von Erkenntnis to describe the way in which science works and says: "Science does not observe the world, but rather calculates possible statements based on experiences with previous statements. What she actually knows is thanks to her

56 Ibid. 113.
57 Ibid. 107.

skill, including cheating, in producing variations in dealing with her own experiences and reacting to them."[58] The problem with using the scientific method is that science cannot easily resolve complex situations with open and evolving variables. The rigidity of science fails when attacking and resolving 'wicked,' ambiguous problems,[59] because, according to Rittel & Webber, science is exclusively capable of dealing with 'tame' problems. There is no room for trial and error when dealing with wicked problems.[60] They remark: "The problems that scientists and engineers have usually focused upon are mostly "tame" or "benign" ones...Wicked problems, in contrast, have neither of these clarifying traits."[61] Since the 1980s, complexity has been recognized as an important part of design practice and design thinking. Complex situations generally contain "wicked" problems, which are "unique" and "ill-defined."[62] Realizing complex situations is not so easy. Despite its wide use, the term "complexity" is ''notoriously difficult to define.'' According to John Flach, there is an explicit connection between complexity and uncertainty...Thus, coping with complexity is synonymous with coping with uncertainty![63] Ambiguity, uncertainty, and the impossibility of knowing all of the fields involved are among the most important characteristics of complex problems. Navigation in this situation is not so easy. The designers must make their way through a dense forest and over a swampy ground, trying to find a path that is constantly changing direction. Stefanie Di Russo, in her study, introduces the language used between designers as containing a sense of uncertainty:

> *Both design teams had to navigate their way through complex and ambiguous terrain, working towards an outcome for a brief that is subject to change. A key indicator of the sense of uncertainty experienced throughout the project was observed in the language used between designers during sensemaking, synthesis and brainstorming sessions. The language expressed amongst the design team was often undeveloped and rarely definitive. Repetitive comments such as "might be this" and "I don't know" reflected the uncertainty both design teams felt throughout the process of the project.*[64]

58 Die Wissenschaft beobachtet nicht die Welt, sondern sie errechnet mögliche Aussagen aus den Erfahrungen mit bisherigen Aussagen. Was sie tatsächlich weiß, verdankt sie der Kunstfertigkeit, Mogeleien eingeschlossen, im Umgang mit den eigenen Erfahrungen Variationen zu produzieren und darauf wiederum zu reagieren. Knorr-Cetina, Karin. Die Fabrikation von Erkenntnis, 1984. http://books.google.ie/books?id=MisTAAAACAAJ&dq=Die+Fabrikation+von+Erkenntnis:+Zur+Anthropologie+der+Naturwissenschaft.&hl=&cd=1&source=gbs_api.

59 Horst W. J. Rittel, and Melvin M. Webber. "Dilemmas in a General Theory of Planning." Policy Sciences 4, no. 2 (June 1973): 155–169. https://doi.org/10.1007/bf01405730.

60,61,62 Ibid.

63 John M. Flach, "Complexity: Learning to Muddle Through." Cognition, Technology & Work 14, no. 3 (December 24, 2011): 187–97. https://doi.org/10.1007/s10111-011-0201-8.

64 Di Russo, *Understanding the Behaviour of Design,* 107.

She explain that: "Surrendering to the unknown amidst uncertainty was an attitude both design teams expressed."[65] Surrendering to the unknown means relinquish control. It is almost impossible to quickly choose a solution among the ways that have been tried in the past, which can lead us to a good end in this situation. "Part of the art of dealing with wicked problems is the art of not knowing too early which type of solution to apply."[66] The way in which we start the process should also be in accordance with the nature of the problem. It means that the primary generator is better to be indeterminate, uncertain, or even inexpressible. Therefore, enframed ideas cannot be considered a suitable solution due to the clarity and certainty they give to the design process from the beginning. Referring to the swampy lowlands that he uses to express the situation of uncertainty in design, Wolfgang Jonas explains that:

> *'Design through research' assumes that the 'swampy lowlands' of uncertainty will be subsequently replaced by well-grounded knowledge. But exclusively scientific research is unable fully to recognise the implications of acting in a space of imagination and projection. The 'knowledge base position' needs to be complemented by the 'unknowledge base position' or by the competencies to deal with not-knowing. It is not science as a method, but science as a guiding paradigm for design, which is being called into question.*[67]

'Unknowledge base position' shows the approach of the designer. In fact, a person who is faced with a wicked or complex problem is faced with not knowing. That is, the essence of the problem is so obscure and unknown that designers or even design teams simply cannot have all of the knowledge needed to face the problem. They cannot define and describe the problem or identify and categorize all of the variables that affect the project. Sometimes, they cannot even find specific precedents for the brief. The way of dealing with the problem is formed from this point. Designers begin with not knowing. This also includes not knowing the problem itself. The wider the spaces of not knowing, the more possibilities are available for movement. Not knowing lies in the essence of design knowledge and helps the designer. Sometimes, relying on existing limited knowledge can only be misleading or prevent you from seeing other

65 Ibid. 108.
66 Rittel, "Dilemmas in a General Theory of Planning." 155–169.
67 Michel, *Design Research Now.* 202.

ways. Therefore, there will be a need for an epistemic break.[68] The concept of not knowing should not be equated with ignorance. In the ideation phase, not knowing implies the absence of reliance on and return to the existing knowledge base concerning a specific subject. I refer to this knowledge as labeled knowledge. Knowledge of the construction of churches refers to a collection of knowledge derived from various architectural styles and construction methods applied to churches worldwide. Knowledge of designing eyeglasses pertains to the insights gained from studying, designing, or making existing eyewear. Knowledge of public transportation apps is the name we can give to the knowledge obtained from studying, designing, or using all kinds of applications that connect a transportation system to passengers to check the timeline, book a seat, or buy a ticket. There are infinite types of labeled knowledge that either we gained before or need to study and research about them to achieve. Precedents, including all types of existing knowledge and information around a particular case, are labeled knowledge. Instead, references generally contain unlabeled knowledge. However, why is it important to refer to unlabeled knowledge and what is in 'not knowing' that is not in 'knowing'? Referencing to a labeled knowledge confines us within the boundaries of that specific knowledge. This knowledge possesses its own specific name and geography. However, abstaining from labeled knowledge does not place us under any specific name and does not define us within any particular geography. In this way, we find ourselves within a broader horizon. The possibilities that using not knowing provides differ from what we gain through interdisciplinary and participatory design. In those systems, each participant usually considers themselves loyal to a specific geographical area of knowledge. Participatory design is an attempt to broaden the horizons of ideas while each participant remains individually constrained to a specific area. While it is better for designers to have a beginner's mind, especially in the early stages of design, they should be able to doubt all of the knowledge and information that illustrate a specific way. Untrusting what has been done so far is an important step. Just

68 Philipp Oswalt, Wissen - Nichtwissen - Entwerfen, 2015. http://books.google.ie/books?id=BueRzgEACAAJ&dq=Philipp+Oswalt+Wissen+%E2%80%93+Nichtwisen+%E2%80%93+Entwerfen&hl=&cd=1&source=gbs_api

like a kid's mind, which is unaware of the existence of structures, frameworks, and labeled knowledge, or even accepted rules and norms. Children can continue playing without organizing the playroom. They can build and destroy in chaos for a long time. They are not interested in using manuals or rules of the games. At the same time, they can have significant ideas. Peter Skillman did the marshmallow challenge[69] with 500 business, engineering, and design students in different universities around the world, including in the US, Japan, and Taiwan. He says: "The engineers in Taiwan were solid. They did not game the rules. They were efficient and methodical but did not get the highest scoring."[70] The result was exciting when he did the same challenge with children. "On every objective measure, Kindergartners had the highest average score of any group that I have ever tested ... the thing I love about children is they will teach you and remind you what you forgot... Children jump in and do it."[71] Untrusting or disregarding known ways and labeled knowledge can also be compared to the mind of a life-sentenced prisoner trying to find an unpredictable way out of prison or to the mind of someone looking for tax loopholes. Designers need to doubt the information that shows them the way. Untrusting what has been done so far is an important step.

Cautious and suspicious, the designer moves forward in the forest's darkness until the path becomes clearer. Intuition in complex situations is not a sudden glint but a process of slowly lightening the path, which continues from the beginning to the end. Observing the behavior of two design teams in two different projects, Di Russo says: "Emerging from complex uncertainty was an increase in intuition. Both design teams 'felt' their way through unknown and conflicting terrain. Knowledge gaps and unknown future states proved to increase the level of intuitive language in both design teams, influencing the designers to abductively "guesstimate" future scenarios and ideal user outcomes."[72] The point is that this path, at the same time as it is found by the passerby, disappears behind, and no trace of it

69 A team-building activity where teams compete to construct the tallest free-standing structure using 20 sticks of spaghetti, one meter of tape, one meter of string, and one marshmallow. This activity highlights the importance of collaboration, innovation, and problem-solving strategies.

70 Original Design Challenge. "Peter Skillman Marshmallow Design Challenge." YouTube, January 27, 2014. https://www.youtube.com/watch?v=1p5sBzMtB3Q.

71 Ibid.

72 Di Russo, *Understanding the Behaviour of Design,* 113.

remains in the forest. A wanderer usually is unable to remember the entire path unless it has been marked. If the traveled route has been recorded, it will probably look like a tangled web, and this is due to the complexity and not knowing of the situation. Consequently, every design solution is unique.

In the analogy of a forest, using not knowing is equal to increasing the sensitivity of our sensors to find the path. Just like when the eye becomes used to the dim light, as the pupil dilates, it gains the ability to see things in darkness. The use of not knowing in design is akin to the insights shared by Jad Abumrad, the creator of the radio program Radiolab, who has been praised for his innovations. In describing his creative approach, Abumrad insists that a journalist must not know. In fact, Jad engages his audience in the exploration and revelation, or, in other words, the process of seeing, moving, seeing, which will be explained later. Through this reflective conversation, audiences find more accurate sensors to perceive complexities and potential paths are gradually seen by them. These paths are the very references that guide us towards the forest's other side. Abumrad states:

> *There's a real correlation between time spent in the German forest and these moments of emergence. And to be clear, the German forest changes. That sense of, the work is just too big to put my head around this, how am I gonna do this, that never changes. But what does change is that the terror gets reframed for you, because now, you've made it out a few times. You can see over the treetops, and into the future, to where, there you are, you're still there, you're still alive.*[73]

The freedom that the use of references gives to the designer can be explained by lateral transformations, while the use of precedents can be compared to the vertical transformations in Vinod Goel's experiment. In 1995, he conducted a practical experiment comparing the use of paper, pen, and hand-drawn sketches in design to a very basic computer-based vector drawing program. For that, he identifies two types of movement or transformations in the design process: lateral transformations and vertical transformations. In a lateral transformation, movement is from one idea to a slightly different idea. In a vertical transformation, movement is from one idea to a more detailed version of the same idea.[74] He

73 Nevala-Lee, "Surviving the German Forest."
74 Vinod Goel, *Sketches of Thought*. (MIT Press, 1995), 119.

demonstrated that hand-drawn sketches, due to the freedom they provide to designers, also offer greater potential for meditative thinking. In his experiment, designers who used computers generated far fewer lateral transformations compared to those who used hand-drawn sketches. In other words, working with software and less ambiguity had caused designers to emphasize vertically transforming their ideas and offered less opportunity to 'see' different interpretations of their drawings. In sketching (both on paper and on the monitor), each line can serve as a reminder of a memory, a form, a meaning, or a concept. A more freely flowing pen, unrestricted by any rules, can glide across the paper and give birth to form and ideas from the void of a blank page. This could be a way of starting from a point of not knowing and a practical approach to exercising it. By contrast, computer drawings (mostly in old-generation design software), usually built upon rules and calculative thinking, have been less dense and less ambiguous, offering limited possibilities for meditative thinking and imagination. Goldschmidt states: "among the unique advantages of sketches as displays that feed directly into the design process are their vagueness, their lack of commitment to scale or level of articulation, their partiality and the ease with which they can be transformed. One can sketch whatever comes to mind, whether or not it is deemed relevant to the task at hand." Both theoretical and empirical research have shown that the design process finds a solution to the problem through unpredictable references. In essence, a degree of unpredictability is almost essential during creative exploration.[75]

Three methods to facilitate complexity in design

To solve complex problems, transformation design uses interdisciplinary collaboration and participatory design to look outside the normal solution space and create fundamental change. Designers in this system proceed with a dynamic co-evolutionary process that can be modified repeatedly according to the conditions. They "identify and maintain operational gaps in order to be able to repeat itself in response to unforeseen problems. The blank spaces remain empty so that they can be filled

75 Philip Nicholas Johnson-Laird, *The Computer and the Mind.* (Harvard University Press, 1988), 258.

differently in the reproduction of the system, depending on how this progresses".[76]

In participatory design, "citizen participation in decision making ought to include "participation at the moment of idea generation."[77] As the graph in the first part of this article shows, with transformation design, we witness a key shift from the design of tangibles to the 'design' of intangibles,[78] and the complex projects that transformation design often deals with are usually related to social, cultural, political, urban, and environmental, mainly macro-projects and services. However, the results of Di Russo's study show that designers ultimately prioritize their intuition over the participants' ideas. In this type of macro complex situation, the citizens themselves are generally one of the variables that may even cause more ambiguity in the project. In addition, due to lack of clarity, uncertainty, and unknown aspects in a complex problem, the kinds of knowledge that may enter into a design solution are practically limitless. However, in practice, only a limited number of the scientific fields will be involved in the project. Civil engineers, structural engineers, geotechnical engineers, water and sewage engineers, architects, project managers, specialists in environmental laws and regulations have participated in the Lake Urmia project. While many other specialists, such as geologists, hydraulic engineers, traffic and transportation specialists, IT specialists, tourism specialist, economists, ornithologists, robotics engineers, cultural affairs specialists, sociologists, psychologists, agricultural engineers, mathematicians, physicists, botanists, zoologist, and perhaps dozens of others that are not even defined in the modern academic system, could be included in the design team as those who have the potential to come up with ideas for the project or play an essential role in the design of a way to connect two sides of the lake. In addition, although the uncertainty in the proposed solution and dynamic co-evolutionary process is the strength of this approach, the successful realization of transformation initiatives is a significant challenge, and transformation design may not adequately

76 Dirk Baecker, "Wie Steht Es Mit Dem Willen Allahs?" Zeitschrift Für Rechtssoziologie 21, no. 1 (May 1, 2000): 145–76, accessed April 15, 2024, https://doi.org/10.1515/zfrs-2000-0106.
„ein System operative Leerstellen ausweisen und bereithalten muß, um sich selbst in der Antwort auf unvorhergesehene Probleme wiederholen zu können. Die Leerstellen bleiben leer, damit sie in der Reproduktion des Systems, je nachdem wie diese verläuft, unterschiedlich besetzt werden können." (translation by author)

77 Elizabeth B.-N. Sanders, and Pieter Jan Stappers. "Co-Creation and the New Landscapes of Design." CoDesign 4, no. 1 (March 2008): 5–18. https://doi.org/10.1080/15710880701875068.

78 D. Jones, "What kind of thinking is design thinking?" Proceedings of the 8th Design Thinking Research Symposium, Sydney University of Technology, (Sydney, New South Wales, 2010), 219–28.

address the challenges in practice. The gap between design concepts and solutions on the paper and real-world implementation can be considerable.

Instead, Andrew Pickering's approach is defined entirely in action. In similar circumstances, he suggests doing without science. In this way, he reminds us of a model of dealing with the world that is not dependent on science and Apollonian powers. Pickering highlights that complex problems cannot be solved by framing. His approach is a kind of acting with the world that does not hinge on science but is currently overshadowed by it. He talks about a partnership and dialogue that do not need to dominate and control the conditions but move in harmony with them. It means acting with the world rather than acting on it. The most significant difference in his approach to problem-solving is that the process of addressing complex issues is accompanied by engaging with influential elements or agencies. In Pickering's method, which he calls dances of agencies, none of the known and unknown influential factors has superiority and control over the other. In this sense, the design process differs from what is usually done in scientific laboratories or by design teams in the office. Sometimes, the designer must surrender and start with pure observation. Pickering suggests abandoning standard methods and instead using 'not-doing.' We need to put aside the illusion of control and what we have known so far due to its one-dimensionality, incompleteness, and definiteness. In a complex situation, more than we know, we indeed do not know. Therefore, it is better not to treat our not knowing as knowing. Not only will it not help solve the problem, but it will make it more complicated. Sometimes, the side effects of a wrong solution could be more harmful than we can imagine, just like the consequences of the bridge's construction on Lake Urmia's life. However, the problem is that the Pickering method does not seem to be applicable to all kinds of problems and his examples are often limited to agriculture and similar cases.

Donald Schön's method – which offers a way to simplify complexities in design process – is labeled as the sequential, conversational structure of seeing-moving-seeing. This approach assists the designer in managing complexities, progressing step by step, and "harnessing the remarkable human ability to recognize more in the consequences of our moves than we have anticipated or described ahead of

time."[79] In his method, Schön suggests the process of reframing the problem. Since designers do not have sufficient information even about the problem itself due to ambiguity and complexity, reframing the problem, reviewing its structure and even questioning the problem will be obvious. Therefore, "design can be considered to be a process to manage the co-evolution between problem formulation and solution generation."[80] In design, just as the solution is not limited to one option, the dimensions of the problem cannot be limited to its initial boundaries. With a conversational approach, they can also change.

Designers should deal with the problem in such a way that it is not seen as concrete and untouchable. In his book How Designers Think, Lawson explains that designers often develop initial ideas about solutions long before they truly understand the problem. That is, in the first step, the problem loses its credibility and rulership. This becomes even more important when dealing with complexity. Jeffrey H Johnson, in his paper, Embracing Design in Complexity, where he talks about the necessity of the design process for progress in the science of complex systems, emphasizes that complex systems inescapably involve changing the problem, and this process contrasts with problem-solving in the conventional sciences where the rules are that the problem cannot be changed.[81] Reformulating the problem, especially in complex projects, allows the designer to consider different possibilities. A wicked problem has no definitive resolution formula but can only be satisfied under current conditions because "there are no ends to the causal chains that link interacting open systems".[82]

Dealing with complexities and solving problems is a step-by-step, interactive dialogue influenced by the designer's initial judgment and their active sensory appreciation of actual or virtual worlds. Designers can easily describe and appreciate the current conditions based on their sensory experiences using words like small, big, narrow, wide, unpleasant, bright, weak, strong, rough, gentle, similar to something (a specific scene, memory, image, phenomena, etc.) and hundreds of such words and sentences. Intuition usually occurs at

79 Schön, "Designing as Reflective Conversation with the Materials of a Design Situation." 3–14.
80 Simon, *The Sciences of the Artificial.* 194.
81 Alexiou, Johnson, and Zamenopoulos. Embracing Complexity in Design, 195.
82 Rittel, "Dilemmas in a General Theory of Planning." 155–169.

the judgment phase and helps in identifying patterns and meanings. "Appreciations are expressed in acts of judgment that we are able to make tacitly, without necessarily being able to state the criteria on the basis of which we make them."[83] For instance, if the initial judgment and appreciation indicate that something is too small or short, the designer will likely seek ways to enlarge it. Afterward, it becomes necessary to contemplate the consequences of this new change and the emerging patterns that have taken shape. In the judgments of the designer, unlike what is expected in the legal system, there is no absolute right or wrong, no definitive conclusion. Each designer may perceive a pattern or a clue to find the way in the forest's darkness from their perspective. We must note that "clues, in the sense we employ the term here, are never universal, and they mean something specific to a particular person under certain circumstances while they may signify something totally different or nothing at all to another person, even under similar circumstances."[84] This means that two different designers may arrive at completely contradictory solutions, yet both solutions effectively solve the problem and lead to a satisfactory outcome. Essentially, as Donald Schön puts it, each designer constructs a unique design world. To judge, a designer is not even obliged to rely solely on the available evidence around the problem. Instead, valuation and judgment can be based on an apparently unrelated idea from outside the problem's context.

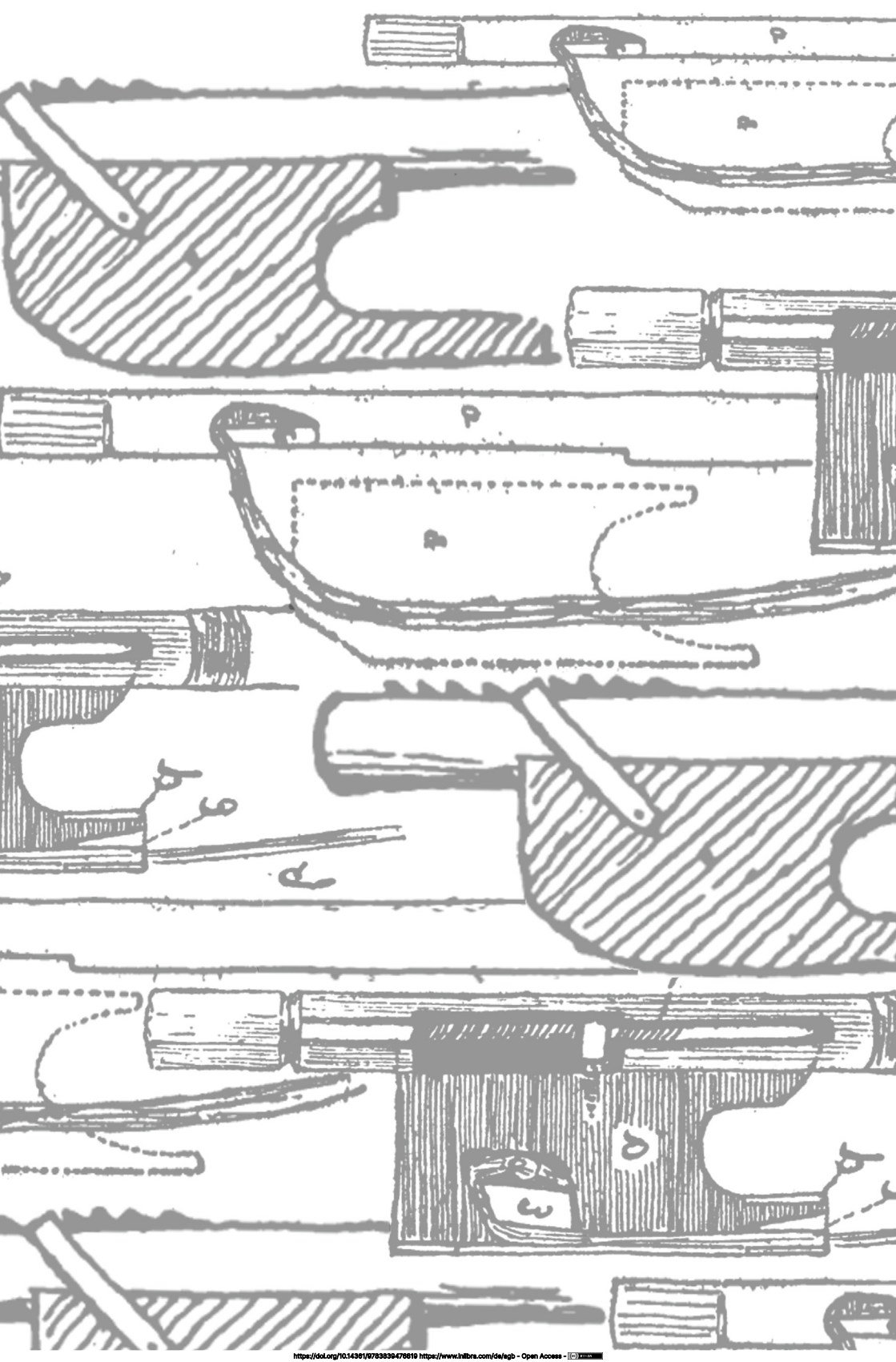
In transformation design, it can be imagined that due to interdisciplinary collaboration, ideas from different fields enter the design process. These ideas can be unrelated to the precedents or related to them. Of course, it should be remembered that since transformation design often attempts to improve an existing situation, the starting point is usually a product, system, or service under operation that needs to be transformed. Therefore, in such cases, the designer can not formulate the problem without at least a vague idea of the past solutions. Accordingly, the primary generator in transformation design often has a trace of precedents in it.

In the Pickering method, precedents along with the designer's knowledge, which is considered limited and incomplete, are put aside, and the designer uses intuition extensively.

83 Schön, "Designing as Reflective Conversation with the Materials of a Design Situation." 3–14.
84 Goldschmidt, "CREATIVE ARCHITECTURAL DESIGN," 258–270.

In Donald Schön's method, the primary generator comes out of the designer's judgments in the very first steps. These judgments are often intuitive. In contrast to a judge in a legal system, when judging as a designer, it is better to see the problem without focusing on existing solutions and precedents. For instance, in the context of the project concerning the connection between the two sides of Lake Urmia, if the design team, by redefining the problem, considered enhancing the connection not as reducing the distance but as enriching it, we would be faced with a completely different solution based on the quality of the connection rather than simply minimizing the time quantity. In this project, the design team based their approach on changing the traditional method of transporting cars and passengers by a ship that had been operating on the lake for years. Therefore, the primary goal was to upgrade this old system. Consequently, the designers were caught in the trap of shortening the connection and bridging the two sides of the lake. However, if the design team had placed previous solutions in parentheses, judgment about the word 'connection' could have involved concepts with different meanings. For example, 'the best route is not always the shortest one.' With this judgmental sentence, the project could potentially have shifted towards a different direction, one that did not necessarily involve building a bridge over the lake. The outcome could have been a longer but enjoyable journey along the lake shore instead of a short trip on the dried-up lake bed. This would mean improving the quality of the connection between the two sides of the lake by constructing a lakeside road and utilizing the lake shore as a tourist attraction and an environmental asset. A solution that, given the cultural and geographical conditions, could have had a significantly positive impact on both the lives of the local residents and the migratory birds.

Every design project is a free and open dialogue. To participate in this dialogue, although both precedent and reference are helpful, precedents, compared to reference, shorten the conversation and support reaching the outcome faster and with more confidence, but references provide pleasant and stimulating dialogue that opens the eye to new horizons.



Christian Rust

What Is It Like to Create a Bow?
Poiesis as research

Prelude

I had been interested in the cello for many years. I had always loved the sound and admired its physical appearance and the people who are able to make it sing. For about the same time, I shied away from learning a new instrument – especially a bowed one – due to the steep initial learning curve involved. At the beginning of the Coronavirus pandemic, I again began thinking about the cello and the same doubts attempted to push the thought away. This time, I did not give in to my doubts too easily. Since I have a background in playing the guitar, I started looking for options for fretted bowed instruments, which would allow for an easier start into this new territory, as my left hand would be on familiar ground. Almost instantly, the viol popped up on my radar. A viol or viola da gamba is a five- to seven-string bowed instrument that is held between the legs and comes in very different sizes and shapes. It had been rediscovered at the beginning of the 20th century after it sank into oblivion about 100 years before. Just like the instrument itself had been lost in history for a while, I had forgotten about it after the first contact through the movie *Tous les matins du monde* by Alain Corneau many years ago and suddenly remembered the sound and music that had fascinated me as a teenager. There are a few modern incarnations of viols and aesthetically unpleasant home brew experiments, but I fell in love with the looks of the original baroque style instrument and its non-standardized appearance. I started writing

to some luthiers to ask if they had an instrument for rent, since I did not want to spend large amounts of money on a new instrument before having tested whether it even scratched my itch. Unfortunately, there was no instrument to be found for rent and the prices for most used ones I came across could hardly be justified. I therefore kept scanning the online classifieds sections for a more reasonable alternative. At the same time, I organized a few lessons from a viol teacher close by. Shortly after, I found an instrument, that I instantly adored. It was from around 1930, had some wear and tear, and a slightly concerning crack, that probably needed repair. Other than that, it looked just beautiful. As with many instruments of that era, this one does have more resemblance to a cello than a baroque viol.[1] The neck is narrower but thicker, it does have an endpin and top and back plates overhang the ribs, but all that added to its charm and uniqueness. The instrument was located in Magdeburg and the owner had the same last name as me. Her father was a luthier and her grandfather, the original owner and former professional cellist had passed the instrument on to her. Although not related in any known way, I somehow liked the idea of the instrument staying in the family so to say. After picking it up, bow and bag included, I went directly to a viol maker in Cologne to have new frets put on, since those were missing. At home I promptly tried the now fully functional instrument. My left hand felt at home immediately, due to my experience with the guitar, but the bowing proved disastrous at first. It did not sound like expected or hoped for, the bow felt weird in my hand, and I had a difficult time achieving anything even remotely similar to a pleasant experience (and sound). As every self-critical and reflective person trying out something new would do in such a situation, I of course blamed it on the material. The bow must be faulty, almost unplayable even, what else could be the problem. Looking back now, the bow really was nothing to brag about and most certainly did not originally belong to the viol anyways, but to a much greater extent, as I must admit, it might have been my incapacity to properly bow. Nevertheless, I suddenly became very interested in the up until then by me only vaguely aware of universe of bows and wanted to find out more about those unruly objects.

1 It should not go unmentioned, that viols in cello form also existed in the baroque era.

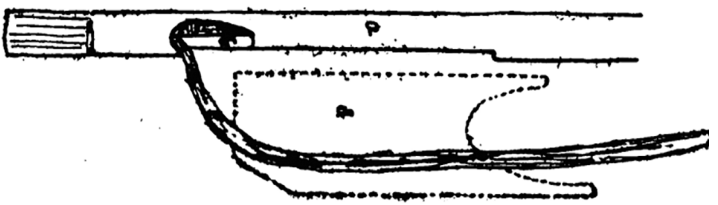
my viol

Three strings to my bow

I wanted a new bow, that I was sure of, one more appropriate to the instrument, one better suited to my lack of skill. Therefore, I started to conduct some research to identify my options. The appearance of bows changed during the centuries with three major forms of construction to be distinguished.[2] The relevant difference for my decision had been the way in which the hair tension can be adjusted, which is necessary because temperature and humidity influence the tension of the hair and accordingly the way, the strings react to bowing.[3] Therefore, while differentiating the three main bow types, I will focus on the area around the frog. A frog, very simply put, is the part of a bow, that sits close to the end of the stick and guides the hair. It can be made of many different materials but in modern bows it is almost exclusively made from ebony.

1. The first type of bow uses a clip-in frog, where part of the stick is carved out for the frog to fit and be clipped into. This way, it cannot move around unintentionally. The hair is attached on both ends to the stick and does not allow for any direct compensation of its tension. This can only be achieved by either exchanging the frog with another one with a slightly different height or placing or removing material underneath the frog to alter its height and the tension.

4



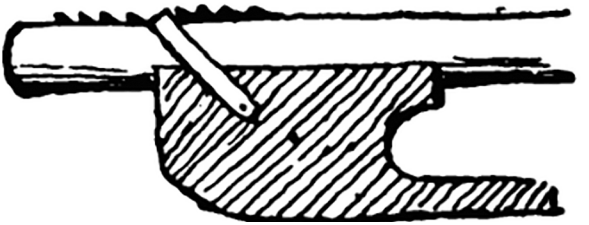
2 Walter Senn, „Streichinstrumentenbau," in *Die Musik in Geschichte und Gegenwart, Band 12*, ed. Friedrich Blume (Kassel: Bärenreiter, 1965), 1551-1556.

3 Playing a viol allows for an additional way of adjusting the hair's tension with one's finger in direct contact with the bow hair but this is used for articulation and not for permanently compensating for improper hair tension.

4 Henry Saint-George, *The bow, its history, manufacture and use,* London 1896, 30.

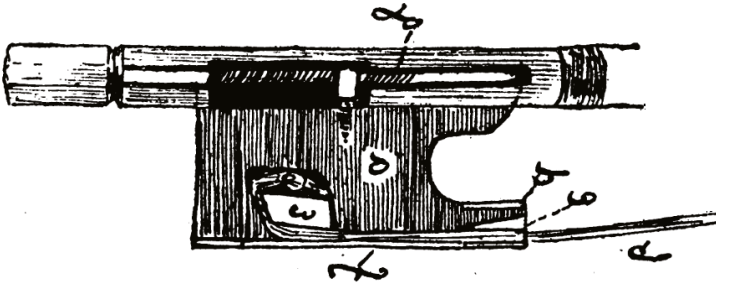
2. The second type is called crémaillère bow and could also be seen as a variant of the clip-in version. There, a ratchet and a hoop mechanism allow for the frog to be moved closer to or further away from the end of the stick and therefore to change the tension of the hair. This advantage over the clip-in frog comes at a price. The extra mechanism is a cumbersome device and adds weight to the end of the bow. This can be seen as the least successful type of construction.

5



3. The third type is the modern incarnation where the frog is fixed, and the tension of the hair is changed by a screw at the end of the bow. Only one end of the hair is attached to the stick, the other to the screwing mechanism. This form of bow is the most complex of the three and calls for additional materials besides wood and hair, namely leather, metal, and various decorative elements. Nowadays it is the version that is used almost exclusively.

6



5 Ibid. 32.
6 Ibid. 91.

What kind of bow would I like to use? Which one would best suit the instrument? During my research regarding those questions, I came across a somewhat heated debate in the printed notices of the German Viola da Gamba society.[7] The argument was about the advantages and disadvantages of bows with clip-in frogs and bows with screw mechanisms. The crémaillère was not even mentioned as a third alternative but I had already ruled it out as an option for me before reading the article anyways. In the 1992 February issue[8] of such printed notices, Annette Otterstedt – musicologist, curator, and viol player – described how she came to preferring bows with clip-in frogs through playing copies of original baroque era specimen. Those copies were initiated by herself because at that time she could not find readily available facsimiles but still wanted to test some common opinions regarding bows that she started to doubt. Generally spoken, one question of hers had been, if the modern bow really is better (for her). In this process several of her own beliefs regarding the length and weight of bows and their construction in general began to crumble through experiencing the results of her design experiments. In the following May issue[9] of the printed notices, the bow maker Scott Wallace responded to Otterstedt's article where he criticized or rather just doubted some of her remarks regarding traditional methods of bow making and some advantages and disadvantages she mentioned, while at the same time giving her credit for undertaking those experiments and the reevaluation of clip-in frogs. He finally summed up the differences he saw in both types as follows:[10]

clip-in	**Screw**
elegant	less elegant
sturdy	less sturdy
not directly adjustable	easily and precisely adjustable

In the same issue,[11] violin and bow maker Robert Schär described the process of building copies of historic bows, starting with studying and measuring them in the collections of museums. He also referred

7 Viola da gamba – Gesellschaft, accessed October 3, 2023, https://www.viola-da-gamba.org/.
8 Annette Otterstedt, „Der Steckfroschbogen," *Viola da Gamba Mitteilungen,* February 14, 1992, 4-5.
9 Scott Wallace, „Zum Artikel von Dr. A. Otterstedt im Februarheft," *Viola da Gamba Mitteilungen,* May 13, 1992, 7.
10 Shortened and translated by the author.
11 Robert Schär, „Vom Recherchieren und Rekonstruieren," *Viola da Gamba Mitteilungen,* May 13, 1992, 4-6.

to the article of Otterstedt and praised the benefits of clip-in frogs as well as highlighting the downside of not being able to adjust the hair tension easily. Otterstedt's response to Wallace's critique can be found in the August 1992[12] issue. Besides very convincing arguments against Wallace's claims, she stressed how difficult it had been to even find a bow maker that would really listen to and finally turn her ideas into reality, not blindly sticking to traditional beliefs and prejudices. The final response[13] of Wallace can be found in the same issue, but only focuses on aspects that do not hold any relevance to my article and are therefore left out.

Weighing all of the advantages and disadvantages and listening to my guts, I took sides for the clip-in frog. This was not due to the historical adequacy of bows with clip-in frogs being more widespread through baroque times, where the viol thrived, but because I thought it to be the better and more elegant concept of a bow. Otterstedt's arguments were more convincing and the whole concept of simplicity resonated with me. Additionally, I am very critical towards traditional beliefs and often prefer alternative underdog solutions or technologies deemed obsolete. Therefore, the somewhat outsider position of the clip-in frog had been another plus.

Research-creation

I could have stopped right there. I was convinced. I preferred the reduced materials and simpler implementation of the clip-in construction. Therefore, I simply would have had to spend a small fortune,[14] buy such a bow and hopefully be happy or find out that my assumptions were incorrect. However, there still would have been unanswered questions then, questions that were relevant to me, the main one for the purpose of this article being:

> What is it like to build such a bow?

This question cannot be answered from a third- but rather only a first-person perspective, through one's own experience instead of reading or listening to descriptions. I also did not want to just study

12 Annette Otterstedt, „Antwort auf den Leserbrief (vgl. Nummer 6)," *Viola da Gamba Mitteilungen,* August 18, 1992, 4.
13 Scott Wallace, "Antwort auf den vorstehenden Brief," Ibid., 4-5.
14 Buying such a handmade bow sets one back 1,000+ €.

finished artifacts of a time long gone. Of course, that is an important part of research. At least, if you were concerned about historical aspects and not just functionality. I leaned more to the historically derived functional aspects which also offered the possibility to build a slightly modified modern interpretation, and not seeing things, in this case tradition, as a given. I hoped for solutions, that tackled the only mentioned and agreed upon downside of the clip-in frog: not being able to easily adjust the hair tension. The answer to the additional open question about how to build such a bow is included in tackling the first one. The final open question about what it would be like to play such a bow, one that I have built myself, comes in third but cannot be tackled in the limited space of this article.

Once again, I opened up my browser to ask the almighty interweb for guidance. I searched for bow makers that had clip-in frogs in their portfolio and had added some means of adjusting the string tension. After quite a while, I came up with three results. This at least felt like an upgrade from the situation mentioned by Otterstedt thirty years earlier, although I am sure I could have found more. And it is very likely, that not every bow maker advertises clip-in frogs on their website. Two of those luthiers I came across used a ratchet between the bow stick and the frog. This reminded me of the crémaillère but here the ratchet was hidden by and underneath the frog. In both cases, the ratchets were made of bone. The third luthier used some kind of wooden pin. From the website itself, I could not figure out much more, other than that it somehow allowed for the frog to slide on the stick. I really liked the website's design and the fact, that the luthier experimented with all kinds of unusual alternative wood species.[15] The exceptionally beautiful appearance of his bows did not hurt my decision and so I opted for his design, since it does not introduce additional materials and the whole concept struck me as elegant and minimalist. I am aware that this has been a purely aesthetic choice at this point but what else should I have based my decision on? I contacted him via E-Mail and after some talk about my intentions and ideas, Michael invited me to visit him in his workshop and stay for a week. This positive response and a feeling that we had very similar opinions reassured me and so I planned a trip to his location in the historical part of Schwäbisch Hall.

15 This seems to be a more sustainable approach since the almost exclusive use of the Brazilian Pernambuco wood in the making of high-quality bows for the last 200 years and therefore its excessive harvesting has led to its status as an endangered species.

overview of one side of the workshop

We instantly clicked and he showed me around his particularly beautiful and organized workshop while we talked some more about his approach and my expectations. Since I specifically came there to build a bow with a clip-in frog, he did not have to convince me of the advantages for my specific project, which he otherwise would have done. For the already mentioned problem of normal clip-in frogs, that tend to be somewhat problematic in changing humidity and climates, he came up with a unique solution. A downside of the alternatives along the lines of crémaillère, including the two concepts of the other two mentioned bow makers is, that if you want to decrease the tension, you first must increase the tension to be able to move the frog at all. This is owed to the principle of the ratchet. Michael instead makes the frog movable without any ratcheting/locking mechanism. He just adds one single tiny pin made of wood to the stick. The frog has a carved-in rail, so the pin only guides the frog. Additionally, the frog is rounded on the bottom with the same curvature as the stick. The frog then is held

in place by the tension of the bow hair.[16] Therefore, if I wanted to lower the tension of the hair of the bow, I did not have to put additional stress on the hair to do so. I can simply slide the frog along the stick. Due to the style, a viol bow is held, and the viol is bowed, adjusting the hair tension and therefore changing the frog's position, is not a problem (for me). Shortly after our initial talk, we went straight to work by discussing what kind of wood to use. A bow stick calls for very specific characteristics in the wood and most species simply cannot be used. Although Michael still could offer several options, we settled for snakewood, a beautifully textured wood of reddish/black color that had been used extensively for baroque era bows due to its density and weight. The frog can be made from many more wood species or bone since the function is not quite as limiting to the attributes of the material. Michael got hold of a very rare and difficult to come by wood called Tubi. It can only be found on the Solomon Islands east of Australia, is dark in color and very heavy but at the same time easy to work with. I was totally amazed by all of the different kinds of wood and their specific qualities. This offered a completely new perspective on wood in general as the colors and textures I have seen ins Michael's workshop were nothing I had ever seen before.

choosing the wood for the frog, unfinished stick as color reference

After the initial choices had been made, it was time to start the more difficult work. The first thing we did was a very rough cut of the piece that would later become the stick and head of the bow. It seemed as if we had made a good choice. As soon as the wood had been cut and released its tension, it showed a slight bend just like it should have been in the finished bow. This allowed us to later

16 A bit of rosin can be added to the stick where the frog is sitting to further increase the friction.

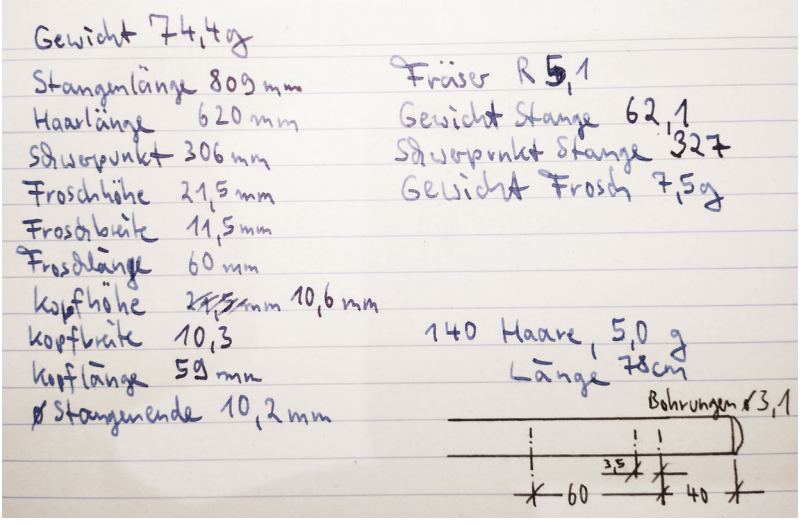
skip the step of bending it with heat. I then started using a plane to bring the piece into a shape closer to the expected end result with a mixture of measuring and eyeballing the thickness and using chalk to mark the parts, that had to be taken off. Initially this was done very roughly and gradually more refined while changing plane sizes. As the planes became smaller, other tools were introduced for further work on the stick and the head like rasps/files, chisel, carving knife, scrapers and so forth, while always checking the consequences of my doing and adjusting the next step and gesture. A frame of reference and experience in the field were substituted by trust in Michael's supervision and a very close observation of my actions and the piece at hand. Already during those few days, I became increasingly familiar with the tools and materials, what to expect from them, how to handle and how not to handle them, how to store and how to place them on the workbench, how to clean them and what to look out for. I slowly developed a feeling for the processes, the movements, a sense for the response of the material and especially gained more confidence. There had not been a blueprint for the bow. Its form evolved during its making. There were of course a few attributes it had to show, a few things, that needed to be a perfect fit, but other than that, there had been quite some freedom in the execution. While getting closer to an intended result or working on something that had to fulfill specific criteria, the intervals of checking with Michael grew shorter again and the material taken off became increasingly fewer. "Can I still keep going? It already feels very thin." His probing eye and bending the stick to check for its reaction made my heart skip a few beats, but he absolutely knew the material and assured me that I was quite far away from any danger. For him, it was not always necessary to measure, but more important to feel the reaction of the material, knowing exactly what it needed to do in response to his probes. Every piece of wood is different, so perhaps with one piece you can or have to take off some more relative to a measured value and with others you simply cannot, or it will break. Therefore, the non-existent blueprint could have only been a rough estimate anyways. When, as in my case, the head and frog are designed on the go and I did not have an exact shape in mind, just eyeballing from other bows which's shapes I liked most, the stick itself then must be adjusted to place the center of gravity in

the perfect position for bowing. This is very important for the bow to be held comfortably without using force to keep it in a horizontal position. The center ideally has to be exactly where the hand grips the bow. When moving the frog, this does slightly alter that center, but the moving of the hand accordingly automatically adjusts for that change.

finishing touches on the bow stick, frog in the box on the right

For me it sometimes had been stressful, especially when thinking about what would have happened, if I were to break the stick or did ruin it beyond repair and would have had to start all over again. This would have meant the end of the bow project, due to the limited time I had planned in. Luckily nothing of that sort happened. I had worked on the stick and frog in parallel for quite a while. When I felt tired from the at times somewhat repetitive removal of material from the stick, I moved to the frog and continued the detailed work on shaping it. Those were two completely different processes for me, albeit using similar tools. Both lines of work complemented each other nicely and I could use one to take a break from the other. I took a close look at the frog and liked its appearance. The dark wood's rounded shapes felt very comfortable against my hand. The

stick appeared to be smooth and had a very nice shine to it. It took a while before the words came out of my mouth. In disbelief I stared into Michael's direction, back to the two pieces of wood and back to Michael again. "I think I am finished." I expected him to answer with an "almost, you just have to …," as has been the case several times before. This time, after checking everything very carefully, he agreed with a nod, "Let's put everything together then." We turned the frog's guiding pin on a lathe, drilled the hole for it and tried moving the frog along the stick. It worked perfectly. However, a bow is nothing without its hair. I chose black over white hair due to the looks as well as the slightly rougher structure being an advantage for lower string instruments – like my viol – whose thicker strings then are more easily set into motion and compensate for my lack of skill. There are two ways to calculate the amount of hair for a bow, either counting or weighing. Since every single hair has to be checked for its quality anyways, we counted them. They were cleaned, brushed to make sure they run in parallel and cut to the proper length. For my bow, finding hair long enough was a challenge, which resulted in only having to trim the tips. Small wedges are used to attach the hair to the bow. I already made the necessary complementing recesses in the head and stick before, and then almost like a surprise it really became a bow. I held the completed artifact in hand after having doubted several times whether I could succeed on time.



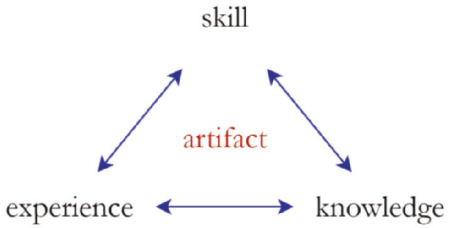
measurements of the finished bow

It took me one whole week to finish the bow and I did not expect it to be such a tedious and labor-intensive process. Judging from the appearance of a finished bow, on first glance it seems to be an artifact of very low complexity, minimal parts, and materials. Getting it to that point – to those exact features from the raw materials and only using hand tools – is another story. Having had no prior experience in building instruments or woodworking, there was so much to learn and new impressions to be had, it totally amazed and still amazes me, getting to know the tools and materials, working with my hands, creating something that did not exist before, shaping the frog and the head of the bow completely to my liking, counting hairs, weighing the materials, localizing the center of gravity, being proud of my own hand's work. Am I happy with the result? I am more than happy and sometimes, especially in retrospect I have a difficult time believing and imagining, that it was really me who created it. It not only looks but also plays so much better than the old bow that I have not touched since. How does the outcome of this adventurous week connect to my research work and where does it lead to next?

Evaluations and speculations

In the following analysis, I aimed for breadth instead of depth, showing possible paths, options and (possibly) relevant positions, to roughly stake out the theoretical field in which I am operating. Therefore, it can only scratch the surface of what must then be further evaluated. This whole project outlined above tried to answer a research question through the creation of an artifact, a poietic action, historically informed and with practical value for today. The term poiesis here is meant as a combination of the traditional Aristotelian interpretation of using purposeful actions to bring something into existence and the usage by Pickering as a "doing without knowledge/science."[17] On the other hand, it is used beyond creation or action but towards an epistemic purpose. Therefore, the goal was not solely the physical object nor the actions that lead to such an artifact. The outcome beyond the bow itself will be elaborated upon through the following epistemic triad composed of gaining knowledge, acquiring skills and having experiences.

17 Andrew Pickering, "Acting with the world: Doing without science," *e-cadernos CES* [Online], 38, 2022, http://journals.openedition.org/eces/7894

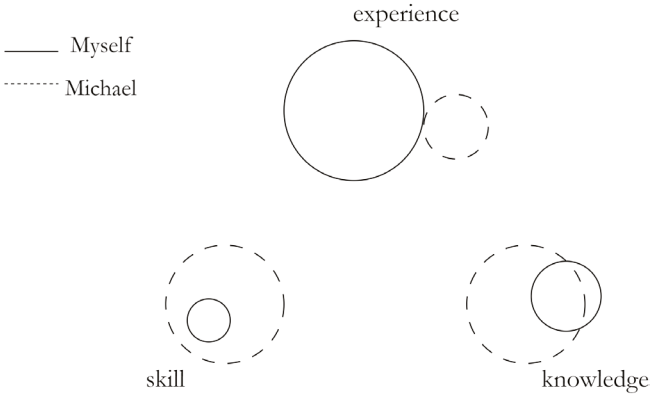


Although one aspect is shown on top, they are not meant to be generally ranked in a specific order or one being always more important than the others. The triangle only shows a momentary state and can be turned to indicate, what aspect is in focus and therefore on top, comparable to a microscope revolver with three lenses for focusing on certain aspects of a subject. I consider them as interdependent equals and am interested in the specific qualities and interconnections between all three, hence the bidirectional arrows from one element to all others. While I created the bow, I gained knowledge, had experiences and to a lesser extent acquired skills along the way. I gained knowledge – for example – about the existence of certain species of wood, where they come from or what they can be used for. I had the experience of using certain tools and ultimately building a bow. I acquired some skill in using the necessary tools. This restriction regarding skill is important. Doing something only once normally does not result in acquiring a skill. Achieving this takes time and practice. However, an experience can be had instantaneously, whereas having experience in a certain field is derived from having had several such experiences. In this aspect it is equal to skill. Regarding knowledge, there have been and still are different and in parts opposing concepts of what it actually is and how it can be achieved. The scope of this article cannot even begin to cope with the subject. I personally tend towards an interpretation as language based with an added truth value and negotiated in specific socio-historical contexts and discourses.[18] A clearer definition is not necessary at this point as long as the differentiation between the three components of the epistemic triad is apparent. The more interesting aspect for my explication is the triad's application on the bow experiment.

While analyzing the role that Michael had played in the creation of the bow, I also mapped my thoughts to the epistemic triad from above. This time, the most relevant aspect for my experiment and

18 Based on Richard Rorty's concept of knowledge and truth as explicated for example in *Philosophy and the Mirror of Nature*.

research question is on top. It is important to differentiate between a mere construction, building or making something, produce a physical result or intentionally create something as an epistemic object, creation as a method of research. This is the reason why I consider the term creation as appropriate, because you create something new regarding the epistemic triad, something that did not exist before.[19]



The dashed circles represent Michael, the solid ones resemble me. We do have overlapping knowledge in some parts, like the general frog principles, whereas Michael has vastly more knowledge regarding materials, tools and techniques and I might have some specific knowledge in the history of bow making and viols. When it comes to the experience of the project, I would suppose that I gained a lot more new experiences, but Michael might have also made some experiences in teaching and helping with bow making. However, the fields or kinds of experiences we had during our collaboration, were very different from another. Therefore, the two circles are separated, only touching in one point, which can be seen as the project of building the bow itself. In the skill department, Michael already possessed all of the skills I very crudely – if at all – acquired, and in a way, he had been an externalized set of skills and experience for myself by answering my questions and being the reference that I myself was lacking. This is why I incorporated my skill circle into his. I could not estimate from the current state of the bow if I were doing the right thing, for how long I should do a certain task, what the specific forms, shapes and measurements were, that I was working

19 It could be valuable to try and incorporate Hans-Jörg Rheinberger's concept of experimental systems and epistemic things into this approach.

towards. In a way I did do without knowledge/science. Of course, I knew about the different modes of frog construction, but I did not have any experience or skill in this field. There had not been a blueprint before, and the head and frog were shaped on the go. Measurements were taken after the construction. Claiming it as an example of a "Doing without knowledge" still could be considered a false attribution, because Michael did possess the role of skill and experience in an externalized form. I would not have been able to finish the experiment in one week without such a form of externalized help, in whatever way this help might have been delivered. The alternative would have been to acquire the necessary skills and experience through many experiments and failures myself, something that would have taken a substantially longer time.

Taking such a closer look to the role of Michael led to important insights. There are different possible combinations or rather separations of the elements in the epistemic triad. However, it is a matter of where one draws the borders of the bow producing system. If it incorporates Michael, then the system of course does have skill and experience. If the border was drawn around me, then the system is lacking in both aspects. Such a seemingly paradoxical doing without skill, which would result from the second version of the system, also directly points to modern production methods, where one set of skills is externalized to the execution by a machine. It should be interesting to compare in-depth traditional crafting to a digital production setup, where you not only can skip the process of making by hand and delegate it to a machine, but you also interact with the tools symbolically and have to at least have a vague idea of the result you want to achieve. You need to have some kind of blueprint or sketch beforehand, and there has to be a description before the production. This directly contrasts taking measurements after the bow had been finished, as I had witnessed. Consequently, you cannot work in correspondence with the material or design on the go, you evaluate on finished objects or prototypes, accept the outcome or trash it and go back to the drawing board. Therefore, there is always an additional layer of abstraction between the "maker" and the made. The concept of "thinking through making"[20] falls apart and

20 As evaluated upon by Tim Ingold for example in *Making: Anthropology, Archaeology, Art and Architecture* (London: Routledge, 2013).

putting actions first is rendered impossible. Making itself converts into an abstraction, a black box. You can only evaluate the input by its output without direct influence on the process beyond formulating the recipe. In such a context, the valuable result is not the artifact, but the recipe to produce it. The generation of such a recipe of course still does need a very specific set of skills, knowledge, and experience, but a very different one from those of the craftman. On the other hand, this delegation allows for agency beyond one's own manual skills. Suddenly the difference between knowing how to make something, being able to make something and making something spans another interesting triangle worth looking into. You can know how to do something, but not be able to. And even if you know how to do something and are able to do it, does not mean, that you will do it. The same delegation of skill and experience to Michael allowed me to work way beyond my personal skill and experience at the time.

Neither in the traditional definition of poiesis nor in the version of Pickering, the epistemic aspects of poietic actions are the center of attention. The explications stop with the end of the poietic action, but what comes next? In my interpretation, Pickering's approach is not just a getting along with a world full of surprise, constant change and emergent behavior, where everything is connected with everything. It can also be read as a way to learn about this world through interacting with it. Perhaps you start without knowledge or without science, because the analytical approaches sometimes fail or simply are not applicable in a specific situation. Nonetheless, you the gain experience, skill and knowledge through actions or in the case above, through the creation of a bow. You might come across systems, that you cannot control, but can interact with.[21] Still, not every reaction of such a system towards your actions is unexpected, and you can cope with unexpected behavior through experience, here in the second form of its definition as a gaining of experience instead of having experiences. Not knowing how a piece of wood will react to your use of a carving knife on it still allows simply having a go and feeling along the material's reactions. However, after several such experiences, I gain experience and skill in the handling of the carving knife and the wood's reactions. In the same way, the

21 And there are also systems that you have complete control over, but whose future states we cannot predict.

Fukuoka[22] method Pickering uses as an example to illustrate[23] the "doing without science" is not just a dealing with the unknowns in certain systems, it is also a form of research. Doing nothing is doing something, it is a decision based on something. You have to at least very closely observe the surroundings, your own actions, and their consequences and then decide to do nothing out of certain knowledges, conclusions and assumptions or experience. Otherwise, it would not be possible to adjust actions accordingly. Actions may come first, but then you have to interpret the consequences thereof or tap into your experience and base the next actions upon those consequences. Even if a system is a Blackbox to the user, as long as it delivers reproduceable or at least comprehensible outputs, the user can meaningfully interact in such a way. It is comparable to improvising. Improvisation as a tool to deal with situations that you cannot fully control does not rain down from the heavens, it is an experience-based set of skills and knowledges. If creating something or acting in that way is executed as a reflected upon practice and not just a practice, if the poietic movement does not end with the finished artifact or the fulfilled action, it then can be used as a method of research. Creation as a research tool seems to be a straightforward endeavor and one would expect it to be an already well-established and researched part of the scientific study of musical instruments. Or as design researcher Bruce Archer puts it to stress the importance of such a method: "There are circumstances where the best or only way to shed light on a proposition, a principle, a material, a process or a function is to attempt to construct something, or to enact something, calculated to explore, embody or test it."[24] Yet, creating something rarely occurs in (traditional) organology beyond building functional copies or restoring originals, whereas the latter is on the decline.[25] An in-depth theoretical discussion and classification still is missing. In the discourse of NIME[26] (New Interfaces for Musical Expression) many experimental approaches

22 Based on the concept of wu-wei, that is sometimes falsely interpreted as doing nothing, the farmer only does the absolutely necessary and in accordance with nature. In Pickering's theory this translates to acting with instead of acting on.
23 Pickering, "Acting with the world: Doing without science."
24 Bruce Archer, "The Nature of Research," (transcribed from a photocopy of the original in January 2009 by), *CoDesign*, January 1995, 11.
25 One example of going above and beyond, is the research of Christina Dörfling, albeit she methodologically seems to be recognized more at home in the field of experimental media archaeology than in organology.
26 https://www.nime.org/.

can be found, and the development of "new" instruments and interfaces mostly based on digital technologies is the main focus. At the same time, past inventions do not receive the necessary attention, whereby the "new" at least becomes debatable or things sold as new actually have been done already a hundred years before.[27] There are of course many other fields dealing with artifacts and their creation, some of which have already bled into organological research. One with an increasing impact worth mentioning is (experimental) media archaeology.[28] As the term archaeology implies, it does have an historical perspective, but analyzing the past to find uses for the present does not seem to be rated very high on their agenda. Further discourses dealing with the study of artifacts and already influencing organology like material culture studies, anthropology of technology and science and technology studies are as far as I can tell from a first overview, seldom concerned with the actual creation of artifacts as a method of research. Design research in the form of research through design, depending on the definition of design and if it involves the actual creation of an object, most of the time neglect what has been done before. The Canadian version of artistic research named research-creation[29] has similar blind spots.[30] All of the positions mentioned above have to be further evaluated to see if those first impressions prove to be true, as well as what can be drawn from them for my own argumentation.

Such a poietical research is highly relevant in certain forms of reverse engineering and experimental archaeology, as I became aware of just recently at the Greifenberg Institute of Musical Instruments.[31] It is important to stress – and the research results at the Greifenberg Institute underline this claim – that the possible questions that can be answered by this method are not limited to "What is it like to…?" They not only build facsimiles of historical instruments but focus on finding out exactly how a specific instrument could have been built to replicate the process itself. Therefore, not just the tool itself

27 Some institutions in this realm are for example the Intelligent Instruments Lab in Iceland (https://iil.is/), the Tangible Music Lab in Austria (https://tamlab.kunstuni-linz.at/), the Augmented Instruments Laboratory in England (https://instrumentslab.org/) or iii in the Netherlands (https://instrumentinventors.org/).

28 This is a still young and very diverse field with different interpretations of what Media Archaeology is or should be, some of which can be far away from actual physical objects. The concept of "Thinkering" might be something worth looking into (https://www.c2dh.uni.lu/thinkering).

29 I prefer this expression because it has the actual creation as a form of research in its name and because it is not charged with the more discussions about university politics surrounding artistic research.

30 Two examples of intriguing exceptions being the works of Ioana Vreme Moser (https://www.ioanavrememoser.com/) and Derek Holzer (https://macumbista.net) that have been done without direct institutional affiliation.

31 https://www.greifenberger-institut.de/.

is important, but also the way in which it had been used. If you want to know how something had been done, you must dig deep into the process itself, try it out, compare the tracks the luthier left and see if you can figure out what left them. You have to create tools and experimentally explore what traces those leave and if something similar could have been used to achieve the result in the past. It is historically informed research into processes. A lot of information about those processes and tools had been lost or needs to be dug out from different and sometimes unconnected historical sources. There is no handbook or a "how to" YouTube video revealing how it had been done. I witnessed the research into how a certain rivet connection in a piano hammer had been achieved. Visually analyzing it microscopically, measuring and documenting every detail, building possible tools, endless trial and error, comparing not only the results with the original parts but also the tiniest scratches the tools left on both, discussing, developing new hypothesis and starting all over. Just for one such tiny part of an instrument the research can take weeks. Of course, it would be easier to just produce a functional equivalent. However, that would not have answered the question of how it had been done 200 or more years ago.

As was shown above, the method of creation allows questions to be tackled and epistemes to be revealed, that strictly analytical or as Pickering would put it "scientific" methods cannot reveal. Therefore, it should be part of the toolbox of every researcher into musical instruments or any artifact if one does not want to unnecessarily limit the breadths and widths of questions to be answered. It is not intended as an opposition but as an extension of other research methods. Additionally, it can not only be used to tackle historical research questions but also ones about the applicability to the needs and wishes of the future, opening organology up to the possibility of not just studying the present and the past, but actively creating and researching for tomorrow. I do not see any reason why organology should "just" be a historical science. Yet, at the moment this almost exclusively seems to be the case. Viewed in that way, the bow is not a replica of a certain historic specimen, but the application of traditional principles in the form of the clip-in frog, combined with a solution for its drawbacks. In the example of creating a bow in the baroque style, it had been a looking into the past to dig out

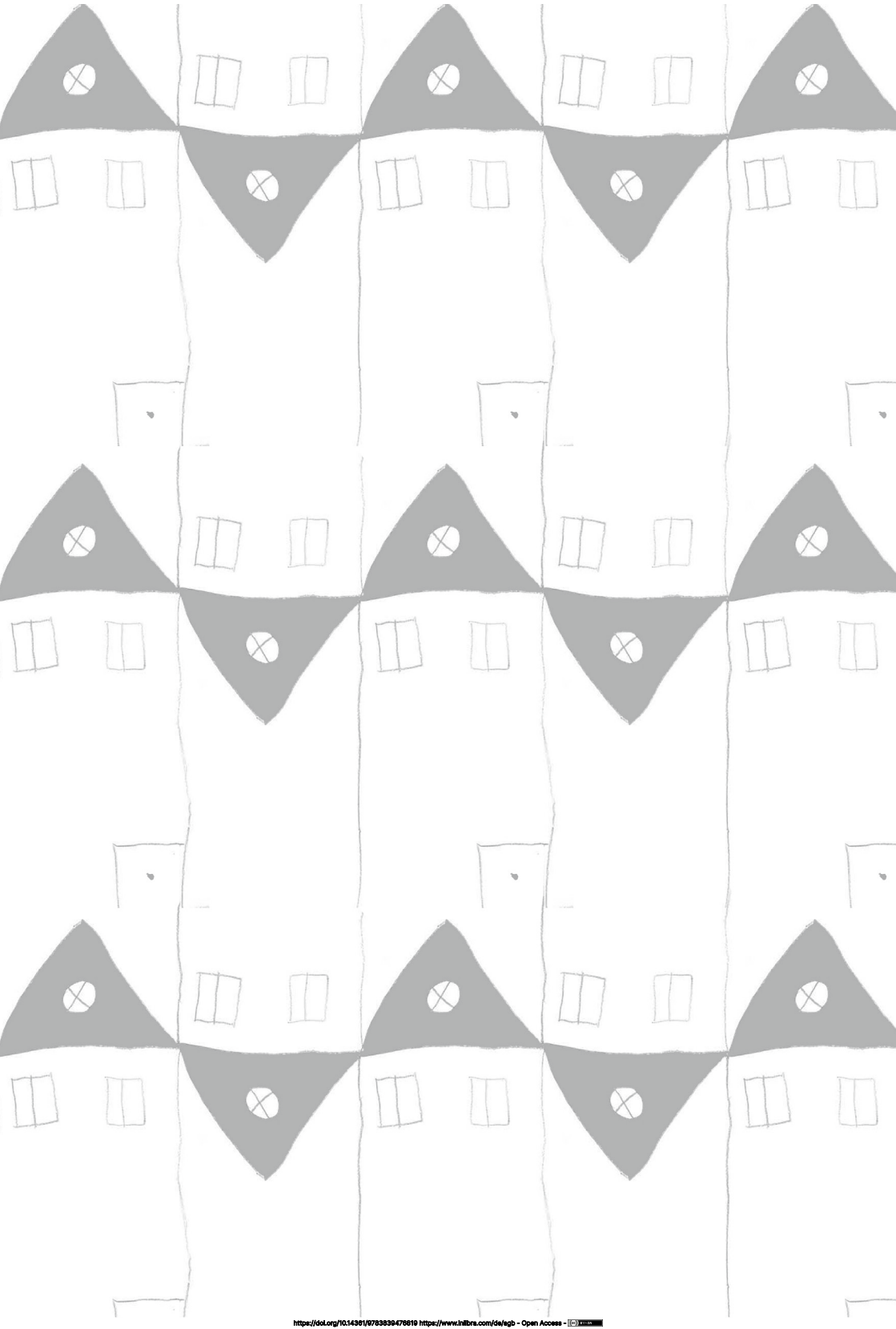
interesting concepts, that might be useful for today.[32] Organology therefore could be branched out into a historically informed speculation of musical instruments. In this way, it would lead beyond making something to see if it works, beyond the artifactual result and its application. It then could additionally answer questions, that deal with "What if…?", not just bringing artifacts into the realm of experience, but shaping the realm itself and expanding upon it, moving it away from a thought experiment in confined spaces right into the wild to explore its possibilities.

The next step will be to evaluate the scientific approaches already dealing with artifacts in research contexts and reference valuable concepts for my own argumentation, incorporate them to develop a poietic framework of research and elaborate, applicate and test it in the field of organology to finally assess their value as an additional method. The goal will be a theoretical poietic framework that allows historically informed research through the creation of artifacts and at the same time produces valuable results for contemporary practices. Otterstedt's experiments and the experiments with different wood species in the construction of bows by Michael can already be seen as practical examples of a such a form of poietical research.

head of the bow with attached hair

32 This is very close to the reading of history in Nitzsche's „On the use and abuse of history for life" and Foucault's methods as explicated in *The archaeology of knowledge*.

bow with attached hair, frog moved in direction of the head to make the tiny black pin visible



Having set forth from that place, it was only natural I should return to it, given the accuracy of my navigation. And my family could have moved to other quarters during my absence and settled down a hundred leagues away without my deviating by as much as a hair's-breadth from my course.

Samuel Beckett

Somayyeh Shahhoseiny

Forgetting
An approach to encountering the complexity of otherness

In connection with the fear of unknowns, Nietzsche's philosophy suggests that the will to power serves as a response to the inherent uncertainty and unpredictability of existence. Humans tend to fear the unknown and seek stability and security. The will to power arises as an attempt to overcome this fear and establish a sense of control and order in the face of the unknowns. The fear of encountering unknowns in the context of displacement is closely related to the disruption of living spaces. It encompasses the fear of being unable to establish a new sense of home, losing connections to one's community, and being isolated or marginalized in an unfamiliar environment or what Nietzsche calls *an adversity*.[1] The loss of familiar living spaces amplifies the sense of the unknown and can contribute to feelings of anxiety, vulnerability, and a heightened fear of the unpredictable circumstances that displacement entails. Additionally, it underscores the role of politics in displacement, as policies and actions can directly influence the loss of familiar living spaces and the subsequent emotional and psychological effects on displaced populations. I distinguish between the politics of displacement and the poetics of movement. Dance, wandering, and journey falls under the category of poetic movements and any form of forced displacement, like forced migration or cultural displacement, under the politics of displacement. The reason can be immediately grasped from

1 Fredrika Spindler, *Nietzsche: Kropp, Konst, Kunskap* (GläNta Produktion, 2010), ch. 2.

the definitions of the terms movement and displacement. Because while movement refers to the change in the position with respect to surroundings, displacement is the change in the position (from an initial position to a final position), regardless of the path taken. Therefore, fear is mainly the result of facing unknowns in forced displacement, which are the lack of choices as well as the limitation in controlling the living situation and uncertainty about returning home. Numerous factors underlie the displacement of populations and individuals in the world. In an era heavily reliant on technological tools, the occurrence and intensity of specific natural disasters, such as hurricanes, floods, and droughts, have been amplified and form new kinds of disruptions. There are also new forms of disasters, such as nuclear bombs, that can give vastly different shapes to new wars. These disasters (whether natural, technological, political, or economic) are the outcomes of opposing yet interconnected elements that shape our overall relationship with the world. In his book *After Fukushima, the Equivalence of Catastrophes*, Jean-Luc Nancy writes: "An earthquake and the tsunami it caused become a technological catastrophe, which itself becomes a social, economic, political, and finally philosophical earthquake, at the same time."[2] The psychological and emotional ramifications often constitute critical determinants in formulating many political strategies for displaced populations. One of these strategies is deliberate forgetting. A closer look at historical instances reveals that the deliberate act of forgetting or suppressing collective memory has been used as a policy to facilitate the displacement of populations. In particular, examples of such displacement are forced migration, colonialism, or ethnic cleansing, where erasing or distorting historical narratives played a role in justifying or perpetuating displacement. Put differently, by erasing or distorting historical narratives, authorities aimed to weaken the identity, resistance, and cohesion of targeted communities and create conditions conducive to displacement and subjugation. Therefore, forgetting is often perceived as a hindrance to our daily lives and a sign of memory failure that happens due to the passage of time and causes the interference of old and new information, or as a retrieval or encoding failure, or repression or as a result of a deliberate political act. However, my aim here is to

2 Jean-Luc Nancy, *After Fukushima: The Equivalence of Catastrophes* (Fordham University Press, 2014), 34.

elaborate on a different perspective of forgetting, suggesting that it can serve as a powerful tool for self-knowledge. By conceptualizing forgetting as a bracketing or a pause or breakdown from daily activities, individuals can create space for introspection, reflection, and self-awareness. The act of forgetting is related to the poetics of movement that leads an individual to a deeper understanding of one's thoughts, emotions, and values.

If we look at the phenomenon of forced migration from the perspective of disruption in our daily lives, this disruption shatters our overall engagement with the world, and we need to establish a connection with a world that we are somehow new to. The existence of this disruption leads back to the nature of human connection to the world. Nietzsche refers to his own illness as a disruption that led to self-awareness and absolute freedom in him. He considers those who benefit from this disruption as those who can establish their own values, which are vastly different from traditional and imposed norms that – in his view – have not led humanity towards true success but have been the cause of human despair throughout history.[3] Subsequently, in the context of forced displacement, this phenomenon can be seen as a disruption for individuals. In his series of lectures on Kierkegaard's *Fear* and *Trembling*, Hubert Dreyfus explains the difference between the terms particular and individual and argues how you cannot distinguish this difference when you read the book in Danish if you do not understand the context, as there is only one word in this language meaning both individual and particular. He articulates that to have a real individual identity is different from being particular, as particularity is not in opposition to universality. Each one of us is a unique human being with associated particular properties and characteristics. However, simply by being an individual, one has a real individual identity related to its individual existence. In other words, being an individual is also called being an exception. Kierkegaard sees the way to be an individual in following the calling, which is also distinct for every individual. He considers this calling as infinite passion, and Dreyfus named it unconditional commitment. This calling puts a person in a situation in which they have to choose between the values of daily life and in accordance with society or their own values.[4]

3 Friedrich Nietzsche, *Ecce Homo: Warum Ich so Klug Bin* (Stuttgart: Alfred Kröner Verlag, 1976).
4 "Hubert Dreyfus - Kierkegaard's Fear and Trembling." Intellectual Deep Web. August 22, 2018. Video, https://www.youtube.com/watch?v=OjfzyqCewdo.

For the connection between individuality and identity, he argues different degrees of awareness. Those who do not forget their identity have higher immediacy and are in contrast to those who have lower immediacy and quickly forget who they are. In this sense, forgetting is self-forgetfulness and becoming someone else. Anything that causes a person to turn into everybody and distance the self, according to Heidegger, is the result of fallenness. As human beings, we fall into certain tasks by default due to social expectations and following social patterns that place us in the safe zone of social life. From Heidegger's perspective, being in the world is being in the world with others (to be in Mitwelt or mitsein). However, the cost of becoming everybody (das Man) is falling into the abyss of daily life and the fall that takes Dasein away from becoming aware of its existence.[5] The example of others with whom man lives in the world is everyone who is considered a model or a hero in social life. This example of others (everyone) determines my Dasein. No one in their daily life is unique and cannot be. Dasein is the subject of others, and its understanding of self is a result and a function of understanding how it differs from others. Therefore, being with others has a two-way meaning of simultaneous integration and conflict with others. Becoming everyone makes Dasein lack individuality, and being too far away from others contradicts the concept of being with others (mitsein). Therefore, the complexity is that even disobeying to become everyone is a kind of companionship. Because Dasein can never be separated from mitsein, it can only try to decide and act independently, at least in some cases and in some moments. Heidegger calls these moments the moments of insight (Augenblick).[6]

The political process aims to resolve disputes in society. It tries to reconcile conflicting interests or create harmony in a situation where alienation has caused instability in the complex individual and social system. One political approach to creating this harmony is linking individual identity to the place of residence, which depends on various factors. One of these factors is the continuity of residence. If the intended place of residence is temporary, people's fear of losing that place turns it into an unstable location where they cannot envision a future for themselves. Consequently, they lack the motivation to improve this place and transform it into a place of

5 Babak Ahmadi, *Heidegger and the Fundamental Question,* trans. by author (Tehran, Nashre Markaz, 2002), 318.
6 Ibid. 320-333.

living. Another factor is conformity with social patterns. For some, achieving the defined social and economic patterns (often the products of power systems' propaganda) is never fully attainable. This achievement of this conformation is facilitated by reducing the diversity of values into a single, measurable financial value. However, if individuality weakens, its manifestations in the public sphere also are weakened. Here, individuality – which stems from the uniqueness of humans – can create a global being while remaining unique/particular by following social patterns. In his book *Individualism, Old and New*, John Dewey criticizes the capitalist system in which individuality has become a victim of financial interests, emphasizing collectivism and conformity.[7] Therefore, in such societies, everyday existence – namely everyday thinking about being – becomes impersonal. No one is their *self*, but their ordinariness leaves little opportunity for reflection on *self*.

We understand that the individual's identity strongly depends on the place of living, where a delicate balance exists between taking action and being subjected to action. Establishing this equilibrium results from perceiving the rhythmic pulse arising from being in the world. It intertwines and merges the inner and outer worlds. Gaston Bachelard describes the home as it comprises inner and outer spaces, private and public.[8] I interpret the inner and private as *self* and the outer and public as *others*. Now, if under certain conditions, like in the case of forced displacement, the inner essence is somehow taken away from the individual, it creates an incomplete identity due to permanent failure or being constantly exposed to failure in establishing the balance between self and others. Preserving historical identity for the displaced population while simultaneously embracing a new identity means interiorizing and incorporating a part of your identity that was once rooted in a land you lost, and acknowledging the possibility of forming a new one. Forgetting allows you to define yourself uniquely with a distinct identity. The middle ground, or the state of being neither this nor that, emerges from the balance between the inner individual aspects and the outer social aspects. If we can call it a task, it is a task of becoming universal from individual or individual from universal. It is nothing but a matter of balancing between interiority and exteriority.

7 Cf. John Dewey, *Individualism Old and New* (Prometheus Books, 2009), ch. 4.
8 Gaston Bachelard, *The Poetics of Space*. (Penguin, 2014), 139.

In this way, the challenge that forced migrants face is a way of being in which they are simultaneously engaged in a new beginning and remaining loyal to the past. Or, in other words, they are engaged in blending old and new identities. The individual's task is then to construct an everyday life that aligns with the new situation while still being entangled with a past. It is a state in which an internal yearning for a spiritual homeland and the past always accompanies integration with the new community. From this perspective, the situation of Ukrainian migrants in Europe and migrants from Afghanistan in Iran differs from other migrants. For some of them, the condition entails a cyclic pattern of returning to their countries of origin, where they revisit their native towns, cities, and homes. This iterative process endures for an extended duration subsequent to their initial compelled displacement. Franck Düvell, a researcher at the University of Osnabrück, has coined the term "Pendel-Migration" for this new phenomenon. He attributes the reason for this phenomenon among Ukrainian forced migrants to the integration of their country into Europe, which allows them to travel without visas and be close to their destination countries. Additionally, some of them partially kept their jobs in their homeland, and for some other, a fragmentation of families is still there.[9] Most of these cases are also the same and relevant to describe the situation of people who forcibly left Afghanistan and migrated to Iran during the past years. However, the point here is that even after returning to their homes, these migrants never regain their pre-migration identity. Even if they return to a place from the past, that place may have become unfamiliar to them. The German adjective *unheimlich* aptly links the concepts of home and place of residence to this sense. It describes a closeness/proximity that has become strange and unfamiliar – a home that is no longer a home. This word carries the weight of the impossibility of returning to the past. For forced migrants, there is a sense of andomness of life, events, and places, which makes having a home something uncertain. It creates an unstable sense of belonging to the place, which is intertwined with their identity. Perhaps the term *rootlessness* can better depict this situation. In de Saint-Exupéry's *The Little Prince*, the character of the rose asserts

9 Franck Düvell, *Europäische und internationale Migration: Einführung in historische, soziologische und politische Analysen* (Verlag Münster, 2006), 131.

that men have no roots, which makes their lives very difficult. The rose expresses this difficulty by stating that rootlessness makes the wind easily blow them away. With this simple sentence, it rejects any interpretation that entails a journey around the world, which adds to human experiences. For a journey, or even wandering, there is an assurance of returning to the origin. In a journey, it is the traveler who changes, while the place of belonging remains in its own unchanged position, waiting for the return of its dweller. However, in rootlessness, the place is lost, and the identity related to it is also transformed. Consequently, the problem of a rootless man is tied to the lack of identity.

I must emphasize that revisiting the past and being entangled in memories should not and cannot hinder an individual from moving towards the future. Self-understanding is not limited to historical knowledge but encompasses an awareness and cognition of new possibilities. As previously mentioned, it is a balance between exteriority and interiority, between the universal and individual. I introduced forgetting as a disturbance in daily life, which opens up the possibility for self-awareness. I should emphasize that forgetting also ties in with remembering. Not in the sense of being in opposition to it but to accompany it in the process of revisiting memories. In conscious moments of revisiting the past, one must have an abstract involvement in ordinary and everyday engagement with the world. In his book *Art as Experience*, Dewey explains the difference between an experience and experience: according to him, the experience is continuous and permanent, whereas an experience only occurs when a task or work is successfully and satisfactorily completed.[10] As long as there is no interruption in activities of daily life, an experience does not occur. The value of an experience lies in its ability to save a person from falling into the repetition of daily life, and it marks moments of self-awareness and insight into one's own existence. Nonetheles, how does revisiting the past or memories become an experience in the moment of insight? In the novel *In Search of Lost Time*, Marcel Proust expresses the connection between self-knowledge and memory. In his work, he strives to place events and images in their rightful place in time. The entire novel is a search into the past that is only possible through the work of

10 John Dewey, *Art as Experience* (New York: Minton, Balch & Co., 1934), 54.

memory. Proust aims to show us that direct and unmediated experience does not lead us to the truth of life and ourselves. Instead, it is the instrument of the mind (or memory) that, through disruptions in emotional rhythms, allows us to touch moments of unfamiliar perception. In this way, memories have the capacity to shed any incompatibilities and – as Proust himself says – only keep inside us what they have experienced. Proust elevates the position of memory to a point where it brings humans to the experience of timeless or eternal time. Memory, in its backward movement, turns the individual towards their own self and into the depths of their existence. Thus, in the presence of forgetfulness (forgetting the *self*) resulting from the daily routine disrupted by an emotional disturbance, it is the memory that brings one closer to self-understanding.

In this context, it might be appropriate to offer a spontaneous response to Gabriel Motzkin's 2012 lecture at Stanford University.[11] In this speech, Motzkin examines the distinctions between history and memory, events and narratives, as well as collective and individual memory. He poses the question of why Heidegger, who extensively explored the concept of forgetting in *Being and Time*, remained conspicuously silent on the topic of remembering. My view is that Motzkin's analysis places excessive emphasis on the various forms of memory, both individual and collective, while overlooking the fact that forgetting also exhibits individual and collective manifestations. Heidegger's focus, as expounded in *Being and Time*, primarily pertains to self-forgetfulness, which, at its fundamental level, is directed towards the individual human being. Contrasting forgetting is the act of remembering, the sole prerequisite for which is liberation from forgetfulness, particularly self-forgetfulness. Therefore, it is essential to underscore that forgetting, as sketched here, is intricately and immediately linked to the remembrance of human existence. The process of memory, exemplified in Marcel Proust's novel, is an inherently personal and individual phenomenon characterized by unexpected moments of insight. This sharply contrasts with the realm of collective memory, intertwined with the broader concept of history and juxtaposed with collective forgetting. Historical identity and collective memory are not opposed to ongoing changes in

11 Gabriel Motzkin, "Memory and the Philosophy of History," video, May 17, 2012, https://www.youtube.com/watch?v=cSKeNfcqdeQ

individuals. Instead, the historical identity is contingent upon the inevitable passage of time, which undergoes alterations and changes with the conditions of the Zeitgeist. This is not in conflict with the routines of everyday life; rather, it is the perpetuation of everyday life across varying epochs that gives rise to such identity. My claim is that it is within moments of detachment from ordinary life and all its associated dependencies, including historical and social identity, that individuals return to a sense of self.

Home: A view from migrant children

By defining *self* in its physical and metaphysical representations and its appearance in the body, one can understand why a person can settle in different houses and get used to new places of living. In this definition, the house is an objective and tangible extension of the self (body). Every time one throws some characteristics of oneself on the design and physical elements of the place of living, the existence of this extension can emerge. Indeed, in this way the place of our life becomes a clear manifestation of ourselves.

As indicated by several research studies, when individuals from diverse social, economic, and cultural backgrounds are asked to articulate their concept of an ideal house, the results are mainly the same, and people describe a single-family house characterized by a square architectural design. These findings underscore the pervasive preference for independent houses as the exemplary embodiment of a family residence. They also show that high-rise structures often fail to gain the acceptance of dwellers as suitable living spaces, as a home is typically envisioned as an independent, ground-level structure.[12]

These findings lead us to a commonality in the way children represent houses in their drawings. Children often draw houses in a similar, simplistic way. This phenomenon is a result of several factors, like peer influence and cognitive development, imagination, and cultural patterns. Various studies (Jean Piaget, Lev Vygotsky, Jerome Bruner, Howard Gardner) also discussed that children rely on simplified symbols to convey their ideas instead of drawing detailed and accurate representations of objects. In most of these studies, such representations are considered to be related to cognitive development.

12 The result of one of the first research of this kind was published by W. Michelson in 1968. Michelson, William. "Most People Don't Want What Architects Want." Society, vol. 5, no. 8, Springer Science and Business Media LLC, July 1968, 37–43, accessed June 11, 2024, https://doi.org/10.1007/bf02804721.

The children's drawings of homes can also be discussed in Jungian archetypes since they are universal (same geometry, form, and landscape) and recurring symbols and seem to be based on a collective unconscious shared by all humans. Jolan Jacobi explains the Jungian archetype as "a profound expression that transcends our intellectual understanding,"[13] and in her article *The House as Symbol of the Self*, Clare Cooper – a landscape and architecture professor at University of California – introduces the self as one of the most fundamental archetypes and adds that people resort to physical forms or symbols that are tangible, visible, and definable to achieve its true essence.[14] The first and most conscious form of self is the body because the body appears both as an external appearance (others or other things) and as an internal appearance (self).

Such an explanation expresses the complexity of individual and collective conscious and unconscious experiences. The manifestation and expression of these experiences can be seen in children's symbolic understanding of the world that exists in them in a completely natural way. Children's drawings of homes are a way of making something implicit (mental schemata) explicit through symbolic representation. In fact, they use symbols that are meaningful to them to communicate their thoughts, feelings, or experiences related to the concept of a home. Bachelard introduces the home as everyone's first world, asserting that the childhood home retains such significance that even if it physically disappears from our lives, it returns to us throughout life and manifests itself in our sleep and daydreams. "Over and above our memories, the house we were born in is physically inscribed in us."[15] The cognitive realm of young children, particularly up to the age of seven, is characterized by a preeminence of form over a connection to objective reality. This formative stage serves as the foundation for their expression in the context of drawings. In the realm of children's drawing, symbolic signs serve as the bridge within the visual language, and drawing serves as a mode of expression that may not always align with everyday conversational language. This alignment can vary, occurring either earlier or later in a child's development.

13 Jolande Jacobi, *Complex/Archetype/Symbol in the Psychology of C. G. Jung,* trans. R. Manheim (New York: Bollingen Foundation, 1957), 76.

14 Clare Cooper, *The House as Symbol of the Self, in The People, Place, and Space Reader* (Routledge, 1974), 168-172.

15 Bachelard, *The Poetics of Space,* 62.

In the practical part of my research, I tried to delve into the experiences of children from Afghanistan aged seven to thirteen, residing in the town of *Aab Sard* near Tehran. My initial purpose was to conduct this research in Germany, focusing on the children of Ukrainian families who had arrived in various German cities from the winter of 2022 following the war. However, despite my efforts over several weeks, I encountered substantial administrative hurdles, rendering this seemingly straightforward project intricate and time-consuming. Consequently, I switched to my second option and held the one-day workshop in Iran.

My motivation behind organizing the workshop was a desire to gain insight into the phenomenon of forgetting as experienced by forcibly displaced individuals. Clearly, direct interviews with them could not serve as an unmediated way to ascertain factual information. An alternative was to observe their behavior, but this option was ruled out in a short time due to its inherent complexities, which I could not deal with. However, analyzing the drawings of children who have encountered forced migration in their lives could present a viable means to advance this objective. Children usually lack self-censorship, often observed in adults, and as explained, drawing serves as a medium for them through which they can externalize and reflect upon their experiences. Drawing is in the same field of expression as playing and speech. Through drawings, children express their fears, joys, dreams, and pains, and you are given leads about their relationship to the world. Two crucial considerations informed the framework of this workshop: first, it was acknowledged that drawing could potentially trigger moments of forgetting in children, and second, by choosing *home* as the thematic subject, the result of the work would provide the possibility of examining the manner in which these children interact with their new living spaces.

To ensure that no external concerns and distractions affect the children's expression, I tried to eliminate all of the external and unnecessary disturbances and stimuli that might otherwise cause discomfort. Therefore, my interaction with the children was very direct, avoiding any excessive introduction. There was also no need for any mediator.[16] It all started so simply. Through a local contact, I already knew that

16 Farsi/Persian is the dominant common language of people in Iran and Afghanistan. Therefore, there was no need for an interpreter during the workshop.

The children sat on the asphalt of the street in the shade of the wall, and the workshop began. There was no mediator and nothing separated them from their daily life but the act of painting.

the residents of this place are mostly Afghans who had relocated to Iran in the past year, and unfortunately have not yet secured legal residency. Consequently, they could not find proper jobs and housing. They live in very small houses with few facilities, which are inadequately furnished. Their living conditions could be described as modest, and they subsisted under challenging circumstances. Upon my arrival in the neighborhood, two children were seated in the shadow of the wall of their houses, and they were talking to each other, which appeared to be a friendly chat with a sense of maturity. I introduced myself directly and without an extensive introduction, and asked them to draw a picture of a home for me using the colored pencils and drawing sketchbooks that I gave them. It was natural to see that the first reaction in facing a stranger with an unusual request was accompanied by doubts and concerns. However, ultimately, with the acceptance of these two children to participate, gaining the trust of the rest of the children in this neighborhood was not difficult. They sat on the asphalt of the street in the shade of the wall, and the workshop began. Unfortunately, due to special conditions in their family (some of them have even lost one or two members of their family, and some arrived in Iran unaccompanied and are living with the help of neighbors and some relatives), immigrant

children often have to accept responsibilities along with their elders. Housework and cooperation in taking care of younger siblings for girls, and aiding the father of the family for boys are among the daily activities of these children. Consequently, what I witnessed during the workshop was crossing the everyday routines, which was easier than I initially anticipated for them.

Soon, the children overcame the fear of encountering a stranger like me. The workshop was conducted within the same neighborhood that constituted their living spaces. No perceptible demarcation existed between the workshop environment and their customary daily surroundings, even to the extent of a bench or a classroom-like space. And this was precisely what I intended it to be. Being in the heart of everyday life but separated from it by drawing. After a while, when the number of children increased, the families noticed our presence and the major challenge was to win their trust for the continuance of our work. With the assistance of local contacts, I succeeded in gaining the trust of their families, enlisting their cooperation in the project through friendly talks.

During this project, the children were tasked to draw their home. Evidently, children from all over the world depict home in a similar manner, and this unspoken tradition also remained applicable to the children within my research. Most of them portrayed idealized homes, indicating that their mental models – harnessed to concretize these depictions through symbols – align with their conceptual ideals.

Furthermore, despite these children having undergone numerous relocations and experiencing diverse social and cultural conditions, their paintings of a home remained remarkably uniform. For me, painting a home resembles a moment of intuition and insight, during which children temporarily distance themselves from the harsh realities of their lives or exhibit a form of forgetfulness. At the time of drawing, this form of forgetting reflects their disregard for the often burdensome circumstances in which these children's families have lived, stemming from years of conflict-induced displacement in their countries of origin or their humble accommodations in the host country. The moment of insight for the children can also be seen as a moment of remembrance, as a recollection of their identities and aspirations, symbolically manifested in their

drawings. Apparently, children do not directly overlay the concept of migration, including exile or refugee experiences – which constitute the core of their existence – onto their mental world. In the eyes of these children, their world retains a perceptible advantage over the harsh reality of migration and detachment from their places of origin. Their current place of residence – regardless of how modest or underprivileged it is – becomes their home. Even if it lacks grandeur or amenities, it is home to them. They also view the houses of the non-immigrant Iranian neighbors (often larger and better-equipped) with a degree of indifference. Another observation offers that children desire to unify all essential elements under a singular conceptual umbrella. Besides the home, prominent components include symbolic representations such as trees, sun, clouds, humans, and animals, which are featured in my studied examples. These elements serve as reminders of the extension of children's own selves (bodies), first encompassing the notion of home and subsequently extending to encompass other objects, both near and far. Although, in general, most of the children have represented the subjectivity of their ideal homes instead of what they see in reality, there are some details in the drawing of my studied group that are worth remarking. When the age of children exceeds seven years, they usually start paying more attention to the tangible aspects of the world around them. They begin to incorporate a heightened awareness of reality into their drawings and pay more attention to changes in perspective and details. In other words, they try to show themselves through the painting of more tangible and detailed elements.[17] When the child grows up, the extension of the body that spreads to the house becomes wider and extends to the alley, street, city, and country. Most of the children in my workshop have depicted the yards and alleys as the unquestionable extension of their existence in their drawings and have even depicted themselves alone or with their friends in the streets. However, the home remains the home, which symbolically has a close relationship with its geometry.

17 Examples of such drawings are few in our study group. The reason for this may be attributed to factors such as limited access to education and other environmental influences.

From forgetting to imagination and daydreaming

The first thing that drew attention when seeing their drawings was the distinction between interior and exterior spaces.

- Most of the children have emphasized the outer space of the house (ten paintings)
- Less than one-third of the children painted the outside and the inside at the same time (four paintings)
- Only one child has paid mere attention to the interior of the house.

Norberg-Schulz and many other thinkers consider human spatiality and identity to be tied to both of these external and internal spaces. However, reading these paintings showed that the outdoor space is more important for them. In the four drawings that also illustrate the interior of the homes, children have used elements such as light and heat to depict brightness and warmth. For immigrant children, home is where they meet their family, those with whom they share memories of their homeland. Outside is where they experience playing with friends and within the natural environment. There are signs of the future for them outside the house. The outdoor elements used in their drawings, such as water, nature, friends, street, and car, all have signs of movement, hope, happiness, and progress.[18] Things with them they have far and close relation at the same time. Ordinary things of today's life of every one of us which is lost and gained again through their loss of homeland and placement in the new land. They even do not own some of the elements they have drawn. For instance, none of them had an aquarium. There were no pools, fruit trees, houses with gables or wooden garden fences in their houses. Instead, the heater that warms up the space and the lighted lamps are present in their drawings as a symbol of warmth, love, security, and support. It could be seen from the drawings that most of these children leave their memories behind the walls to go outside their houses to look for dreams and the future. One could argue that for migrant children, the walls of their place of living are the boundary between memory and imagination.

18 NDFAuthors. "Learn to Decode Children's Drawings - Novak Djokovic Foundation." Novak Djokovic Foundation, accessed February 14, 2023. https://novakdjokovicfoundation.org/learn-to-decode-childrens-drawings/.

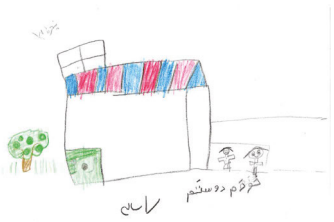

The house of two children is shown in these two photos. The workshop was conducted in the shade of the wall of this house.


Two of the children's drawings. Houses depictions are far from reality.

In studying these drawings, I discovered that imagination was a concept I had missed in analyzing the phenomenon of forgetting. The presence of imagination became visible to me when I realized that the children's drawings of homes have no resemblance to the reality of the houses they live in. Only in two drawings we notice that the children have tried to accurately picture their current living situation. In one of them, a small black home in the bottom right corner is depicted, which symbolically emphasizes that the inside is less important than the outside for this child. Experts believe in children's drawing, small figures drawn at or near the lower edge of the paper, or in a corner, express feelings of inadequacy or insecurity. Indeed, when it comes to positioning on the page, apparently the right side relates to an interest in the future, and a need to communicate.[19] Placing a small house with the shaky lines in the bottom right corner of the painting reflects the child's interest about the future, and the lack of a sense of belonging to the past and the current home. The feeling of not belonging at home primarily due to inadequate family support became apparent even in the short conversation with

19 Ibid.

She depicted a small and black house in the right corner.



In the right side of this drawing, the child has written: "my friend and I." She also explained that she and her friend are playing outside on a rug.

this child after the workshop. Another drawing showed a disorderly house, while the area outside the house was depicted as secure. This painting was created by a child who positioned the building's sole window on the roof and pictured herself on the opposite side of the wall, playing with her friend on a small carpet (The child provided a description of these specifics after completing the drawing). With the exception of these two drawings, the rest of the children's works differ significantly from their actual living circumstances.

A combination of past memories with future daydreams.
The imagination of a 12-year-old girl from Afghanistan who recently migrated to Iran through a difficult path.

One can see the zenith of this different picture in the mushroom hut. In this enchanting moment, a young girl temporarily set aside her household responsibilities to fully engage in the workshop, allowing her imagination to seamlessly blend past memories with future daydreams. A tiny plant next to the window and a small pond in the garden, reminiscent of the homeland, symbolized her past, and a desire to have a goldfish aquarium and an imaginary place to live coming from somewhere in the future.

Just like a little girl whose imagination had given her the power to have her desired private room depicted like a magic door hanging outside the house. And finally, the most peculiar of all drawings was the one in which the imagination could connect the past memory of playing kites in the homeland to a home in the future.

She decided to draw her desired private room like a magic door hanging outside the house.

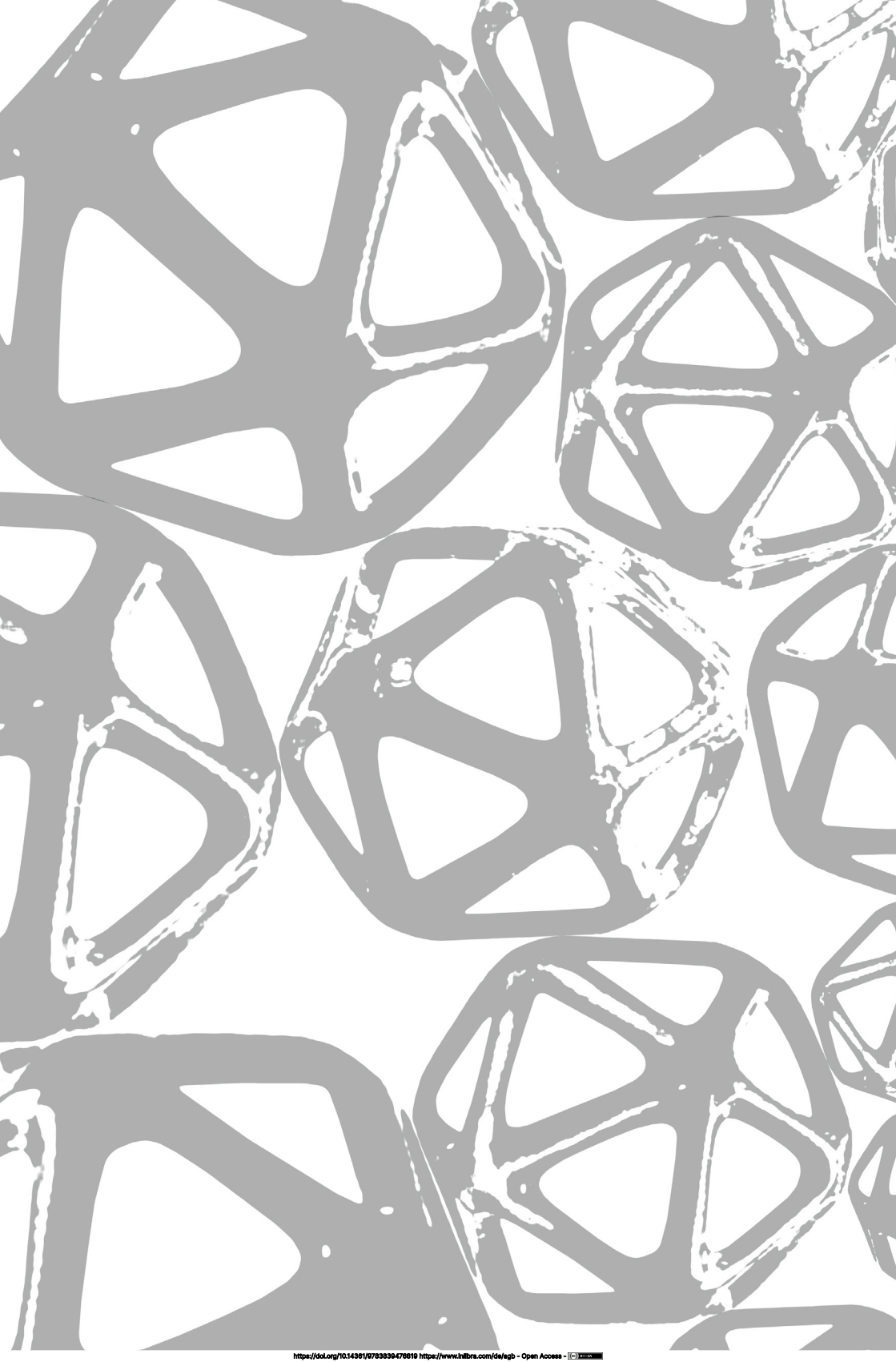
A profound link exists between memory and imagination, as memories serve as a catalyst for the imagination's flight. They give wings to the imagination. And because the experiences and memories of migrant children are more intensive than those of children who have not experienced displacement, they often have a heightened ability to turn past memories into daydreams. Therefore, they find it easier to immerse themselves in the realm of fantasy, casting aside present circumstances in favor of drawing upon their past encounters. In the drawing of girls flying kites, the distinction between the past and the future, inner and outer, *self* and *others*, has disappeared. The physical boundaries and walls of the depicted house have vanished, leaving a sense of transparency within the home, akin to the transparency of joy and play shared with her friend. Looking at this painting, I realized that the children have the power to forget not only in their drawings but also when they play. Forgetting is the gateway to entering the realm of fantasy. Children fantasize by painting and playing and gain empowerment and strength through this.

Here, the walls and border of the depicted house have been omitted to show no border between the past and the future, inner and outer, "self" and "others."

The elements indicative of play within these children's drawings are prominently displayed in five specific drawings. These include cheerful facial expressions, open-handed gestures, the presence of friends, depictions of kites, and scenes set in natural environments, all of which strongly suggest engagement in play. During play, forgetting plays an essential role in dispelling the fear of becoming lost. In these moments, children no longer realize the strangeness, unfamiliarity, or hardship of their living situations. Instead, their imagination becomes a catalyst for altering the reality around them. Those of us who have experienced becoming lost – even for a few seconds – in childhood can confirm that the sensation of being lost is more challenging for children than for adults. However, children are able to forget the existing situation and start to play more easily, since in children the imagination can be shaped more effortlessly. For a child seeking ways to relate and communicate with a new living environment, both drawing and playing quickly help to find ways to enter the realm of imagination and pause in the routines of everyday life. In fact, this workshop reminded me that forgetting is the first step. Forgetting can only take us to the train station. For traveling, one must board the train and embark on the journey. This means that imagination is an indispensable tool to explore and know oneself, functioning as a lifesaver for migrants. When coupled with the power of forgetting, it enables individuals to carve out unique identities and define themselves as *individual* within their new surroundings. A poetic expression can better metaphorically describe complexities – like the relationship between the home and self – that everyday and formal expression is incapable of.

In the final days of March,
The migration of violets is beautiful.
In the bright midday of March,
When they bring violets
From the cold shadows
Into the atlas of spring's fragrance,
With soil and roots,
Their wandering homeland
In small wooden boxes
In the corners of the street,
A thousand whispers within me:
Oh, I wish,
I wish a person could carry their homeland
Like violets (In boxes of soil)
One day
With themselves
Anywhere they desired,
In the clarity of rain,
In the pure sunshine.

Shafiei Kadkani



Tobias Bieseke

Ndinguwe
Dealing with unfamiliar experiences in virtual worlds

Intention

The "Ndinguwe" research project of the FH-Dortmund University of Applied Sciences and Arts investigates the interaction between perception and narration in virtual space based on head-mounted displays (HMDs). The central research question thus emerges as follows: How do the participants integrate experiences with unfamiliar forms of perception into their personal space of experience? The focus is on three main points: first, the self-representation of the participants as avatars in virtual space; second, analyzing the relationship between virtual objects and their influence on perception through haptic feedback; and third, the interface between the virtual environment and the real world in so-called mixed realities (MR). In order to implement the investigation of the research subject in the context of artistic research, a research group[1] was assembled to develop an experimental setting that would generate multiple perceptual states that were unfamiliar to the recipients. The unknown that is at issue here finds its first expression in the word Ndinguwe, which means "I am you" in the Xhosa[2] language.

In the experiment, perceptual situations are created that for many participants do not correspond to their familiar world of experience and accordingly represent a first contact with unknown forms of

1 The research group comprises Harald Opel (artistic director of storyLab kiU), Tobias Bieseke (project management), Jan Schulten (programming), and Azziza El-Yabadri (art direction).

2 Xhosa is one of the official languages in South Africa, in which former President Nelson Mandela coined the philosophical term Ubuntu, which means "I am because we are." Ndinguwe with its meaning "I am you" is a schematic reduction and further development of this conception of existence. Project trailer: https://vimeo.com/915943769

perception. Such initial contacts are of particular importance because the experience is consciously perceived and thus receives a well-founded categorization. The spectrum of unknown perceptions can even affect perceptions to the extent that forms of haptic hallucinations can occur, or it can take away subjects' control over proprioception.[3] The experiment transports the self-perception to the virtual avatars, which are equipped with characteristics that are considered discriminating factors (age, gender, body composition and ethnicity). The simulated first-person perspective of these existences is experienced by the participants and reflected upon with the research team. Furthermore, there are encounters with haptic objects such as a ball or a chair, which are interactive parts of the experiment. The application does not use any visible control elements, but the interaction happens through the body actions of the participants, which are familiar to them from their lifeworld. These experiments lead to actions of unfamiliar perceptions in interaction (e.g. unfamiliar self-image, interaction with invisible persons, etc.). This is discussed in relation to various events, such as interacting with a ball or facing a virtual self-representation. These states of reality are analyzed and contextualized using the schemas of postphenomenology to elaborate the relation between human perception and technology.

Human-technology relationships

In his approach to postphenomenology, the philosopher of technology Don Ihde structures the relations between humans and technical artifacts into different *human-technology-world relations*.[4] Regarding the experiment, the scheme of *alterity relation*[5] is essential, in which the technique – following Ihde – becomes the *quasi-other*. Ihde critically remarks on this anthropomorphism that technology is extrapolated to what technology as a medium cannot achieve, namely, to be an optimized human being. Experiences with these technologies will not be experiences with artificial, more efficient humans, but experiences with the *quasi-other*. However, to appreciate how such technologies change human experience, there must be a recognizable differentiation

3 Self-awareness of body position or limbs in space.
4 Don Ihde, Technology and the lifeworld: from garden to earth, The Indiana series in the philosophy of technology (Bloomington: Indiana University Press, 1990), 72.
5 In addition to the *alterity relation*, Ihde further differentiates in the schemes *embodiment, hermeneutic or background relation* to describe different human-technology relations.

of the relations between subject, technology, and world, Ihde[6] argues. For the *alteration relation*, he developed the following formal notation of the technologically mediated world relation:

Human —► technology-(-world).

This schema means that humans relate to (—►) technology, which either represents its own technical world (technology-) or is related to the real world (-world). This also applies to Ndinguwe, in which the participants partially or completely lose their visual relationship with the world by means of technology and are confronted with an optical, technical representation of the world. The subject is immersed and enters a computer-generated environment into which their self-representation is depicted as a human imitation (*the quasi-other*). Besides the named scheme, Ihde distinguishes between micro- and macroperception.[7] While microperception refers to the sensory perceptions of the subjects, macroperception refers to the culturally and hermeneutically mediated perception, which is thus always characterized by interpretive and design performances. For the evaluation of the experiment, it is exactly these microperceptual classifications that are of interest, which is why the method of microphenomenology was used for the evaluation. There are approximately 70 evaluations, of which, only the six doctoral students of experimental computer science at the Academy of Media Arts (KHM), including Georg Trogemann, will be focused on in this text. The experiment was created within the framework of this doctoral program and allows a precise observation in relation to the genesis of this project.

Experiment setup

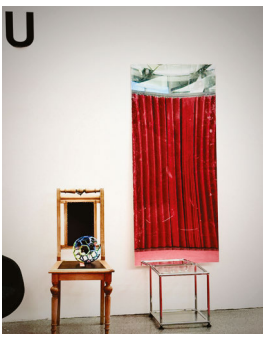
The transportable setup must be able to create a physical self-representation, track objects, and depict the real environment via cameras. Initially, the experiment is a virtual reality (VR) experience, which can be experienced via an Oculus Quest Pro HMD and within an exclusively prepared environment. The experiment was preceded by a six-month development process that explored a wide variety of technical methods towards implementing virtual self-representation,

6 Ihde, Technology and the lifeworld, 229.
7 Ibid. 29.

MR, and haptic feedback. In this method, the given technical possibilities of the HMD were modified for the experiment, such as controllers as tracking sensors or the use of the HMD integrated cameras (passthrough) for mixed reality parts in the experiment. Since the mobility of the project is essential for the evaluation and the experiment, we did not use a spatial constraint and used only mobile objects (mirror, prepared ball, and chair). These objects are tracked for the connection between the haptic object and its virtual representation and are given a position in real space.

During the experiment, the participants are sent on a linear narrative journey with various interactive passages. A chronological script was prepared, which corresponds to the format of a classic cinematic screenplay.[8] This script is an interactive construct with an experience path that follows the patterns of classic narratives.

The participants are understood here as "context-creating living beings"[9] who independently create a coherent experience in interaction with the system. Actions can be divided into passive and active interactions: passive interactions include interactions with the mirror, passing the curtain, or watching the world, while active interactions include playing with the ball or interacting with the chair. The various scenes are loosely related to each other in terms of content and are connected associatively to form a plot or not. The scene chronology is composed as follows: MR intro, Montepulciano walk, mirror room, MR mirror room, ball game in the park, haptics and flying, and the MR outro.



Prepared chair with controller.

Hex Ball XXL with Controller.

Mobile objects of the experiment.

8 Link to the script, accessed August 17, 2023, https://drive.google.com/file/d/1Zde7qnUmyKiMkCQ3n-LXsald6alJ5wVX/view

9 Referring to Ihde, sociologist Alexander Schmidl highlights that subjects not only see, but always see "something." And what is seen they relate to their biography, their situation, their intentions or their life narrative. Alexander Schmidl, Relationen: eine postphänomenologische Soziologie der Körper, Technologien und Wirklichkeiten, Erste Auflage (Weilerswist: Velbrück Wissenschaft, 2022), 36, 62ff.

Evaluation

The evaluation was conducted with the support of the method of microphenemonology, which has its roots in the psychology of the Würzburg School. At the center of this method is the subjective "experience" of the participants, which is simultaneously expressed in language. Ideally, a kind of flow is created in which the perceptive mechanisms, associations, moods, reflections, or observations of the participants can be expressed in words. Thus Gerhard Benetka and Thomas Slunecko write in their text: "»Erleben«, das zur Sprache kommt" ("»Experiencing« that comes to speech"/ translated by the author):

> *Microphenomenologists want to induce with their questions a kind of experiential trance, in which one does not look back on what has been experienced, but in which the experience is held in presence and spoken from the epistemic authority of this current experience. They want to go, to put it in a phenomenological turn, to the experience itself – and not to be content with the memory of what has been experienced.*[10]

Microphenomenology can be used as a method to explore the processes of microperception, which Don Ihde describes as subjective perceptual processes that have not yet found a cultural and hermeneutic classification. In this way, parts of the experience are situationally transparent and increase intersubjective comprehensibility. Of course, this method is misappropriated for the artistic research applied here. As described, it has a different structure and pursues its own production goals. The results varied accordingly. Some participants felt overwhelmed with the task of translating the experience into language. With others in turn, one could document numerous descriptions and associations in the event moments.

Experiment documentation

Using this method, approximately 70 evaluations were collected, with each run taking about 20-40 minutes. An attempt was made to record each evaluation both from the first-person perspective of the headset and from the external perspective of an external camera with image and sound. A room microphone was used to enhance the audio quality and synchronization of the inside and outside cameras.[11] Holistic documentation was created for around

10 Gerhard Benetka and Thomas Slunecko, „»Erleben«, das zur Sprache kommt", Journal für Psychologie 29, Nr. 2 (o. J.): 30, https://doi.org/DOI:10.30820/0942-2285-2021-2-17 (translated by the author)

11 The participants were informed before the recording that they would be recorded with their eyes and recognizable parts of their faces obscured by the headset.

90% of the evaluations. During each interview, a handwritten script was prepared to record the most important statements. The videos were synchronized in editing software and the respective images were arranged side by side. For the evaluation, the verbal statements were transcribed.[12] Concise actions were noted in parentheses (e.g. becomes scared, looks at hands, etc.). Relevant statements were marked and noted in time using the time code. Later in this text, the relevant statements of the six doctoral students will be quoted and analyzed.[13]

The experiment: Step by step

MR intro: At a defined starting point, the HMD with the already-launched application was placed on the head or in front of the eyes of the participants. Through the HMD, participants saw the real space with the addition of a portal in which a cube was floating. The cube contained the word "Ndinguwe." The following words resounded in continuous repetition: *"Touch the ring and follow the circle to enter the rabbit hole."* At the back of the room, a four-digit code number was visible and randomly assigned to the participants. The loading function of the first scene was triggered when participants reached the portal and moved their hand along the outer ring.

Subject enters in MR Intro Ndinguwe. On the left, the subject is seen in the room. On the right, the first-person perspective of the subject.

1. Montepulciano corridor: After the scene loading process was complete, the mixed reality application started. A virtual corridor appeared and moved towards the users, with numerous holes in the walls of the virtual corridor allowing a view of the real environment. Video portraits could be seen on the walls of the corridor, and a

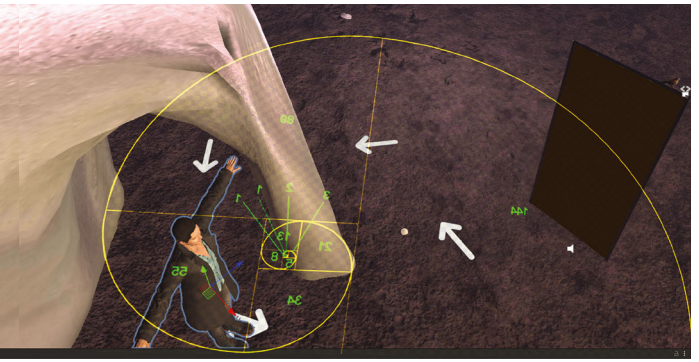
12 „Transkription Evaluation Ndinguwe KHM – Google Drive", accessed October 05, 2023, https://drive.google.com/drive/folders/1x3hwbSspnn55RvVpZBvU8ASba2zyfwyq

13 „(27) Ndinguwe Videoevaluation KHM - YouTube", accessed October 05, 2023, https://www.youtube.com/playlist?list=PLM5l1cypHpWmqoh3yA-DTWiigsiyEnGnm

voice could be heard from offstage speaking a poetic text. The corridor showed the upper corridor of Palazzo Ricci in Montepulciano, Italy and referred to the first directional experiment: "Draw a straight line and follow it."[14] Visually, the corridor surrounded the participants and slowly passed by them. The aim of this first scenario was to ascertain how the combination of VR and MR worked and how the subjective experience of proprioception behaved with two different visual experiences of motion: one that was spatial motionless (MR) and the other one with the motion of the virtual corridor. At the end of the corridor, the participants reached a room hidden behind a curtain. A ball appeared and after a short pause it flew towards the participants' heads. After that, the next scene was loaded.

2. Mirror room: The mirror room was architecturally modelled on a spiral shell and based on the proportions of the Fibonacci sequence. In this space, the participants started at an archway and circled a central column, encountering a mirror that showed them their virtual representation, namely their avatar (the *quasi-other*). Near the mirror, an inner monologue of the respective avatar could be heard, which referred to the avatar's personal fate.[15]
The participants could then try out their interaction in front of the mirror while listening to the narration of the character. Their visual representation was limited to gestures, their upper body, their position, and the movement of the fingers. Facial expressions were not displayed, and the position of the legs was calculated below the position of the upper body via an algorithm. As a result, the legs followed the movement of the upper body with a somewhat delayed, sometimes grotesque appearance. When the participants crossed the starting line, their respective avatar transformed in the following sequence: a) homosexual man, b) Ukrainian woman without a hand, c) old man with dementia or d) African refugee. The choice of characters was based on characteristics that favored discrimination (age, gender, physical condition, and ethnicity). There was a transformation process from passive to active interaction because, depending on how much

14 This is a study trip of the doctoral students to Montepulciano in the summer of 2022, during which they worked together experimentally on their respective doctoral topics. Tobias Bieseke u. a., Montepulciano Journal - The poetics of Making (Verlag der Kunsthochschule für Medien, 2022), 59, https://e-publications.khm.de/frontdoor/index/index/docId/238?fbclid=IwAR1laFz57K_BeEo9BY_RBV_dh6L60-j4s3_jmncLdKfuVsJpiZSHRgNYreo
15 Fatma Aydemir und Hengameh Yaghoobifarah, Eure Heimat ist unser Albtraum: Mit Beiträgen von Sasha Marianna Salzmann, Sharon Dodua Otoo, Max Czollek, Mithu Sanyal, Olga Grjasnowa, Margarete ... Paukenschlag zur aktuellen Rassismus-Debatte, 10. Aufl. (Berlin: Ullstein fünf, 2019).



Shell walk with Fibonacci sequence

time the actor spent with a character in front of the mirror, the character changed the following scenes. After the participants followed the arrows around the center column four times, the next room was loaded.

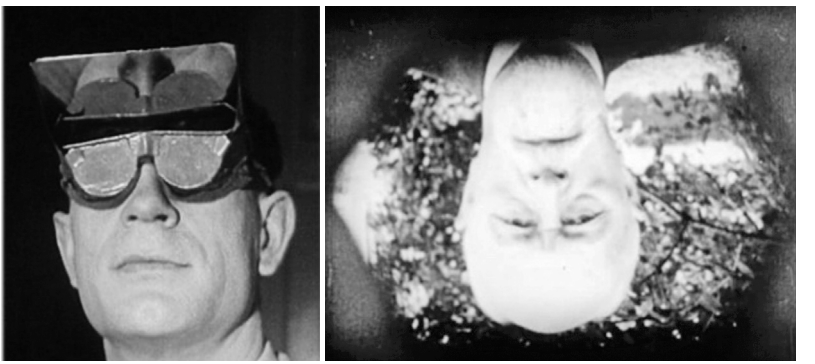
3. MR mirror room: In this space, the participants returned to mixed reality and saw a virtual and a real mirror. In the virtual mirror, they were shown the avatar with which they had spent the most time. In the real mirror, they saw their physical reflection (with HMDs). When the participants look down at themselves, they saw their virtual body optically superimposed on their physical bodies. The visual experience of being overlaid by a virtual avatar offered an altered view of the self and its virtual representation. After a period of 1.5 minutes, the next room was loaded.

Actor touches the mirror with virtual hand

4. Ball game in park: The fourth room was a city park scenario made from a three-dimensional reproduction (Google Earth) of Dortmund's Stadtgarten and Friedensplatz. The participants heared a voiceover providing hints about what to expect. An abstract structure appeared, reminiscent of a tree, from which balls were shot at the participants with a percussive sound. Participants could either block the balls with their hands or avoid them. The ball firing was interrupted twice with a short pause, during which the voiceover spoke again. With each break, the frequency of shots increased, and the balls came from additional directions.

If the ball collided with the participant's head area, their vision in the headset turned orange and became blurred. The challenge of this situation could not be completely fulfilled, given that not all of the balls could be deflected, nor could all of them be dodged. This provoked a stressful situation in which unexpected actions may occur (e.g. falling or taking off the HMD). After this phase, a double (the *quasi-other*) – in the form of an avatar – appeared in front of the participants and imitated their tracked hand and head motion but could not walk. This was different from the mirror image. When the participants raised their left arm, the double also raised its left arm (from the participant's perspective), meaning that the avatar was therefore not mirrored. A ball appeared in front of the participant, and a voiceover instructed the participant to hit the ball back and forth between themselves and their avatar. This was intended to be difficult and was informed by experiments made by experimental psychologists Theodor Erismann and Ivo Kohler with the inversion glasses in the 1930s. The researcher observed that it takes an average of three days until the brain has adjusted to such inversion movements.[16]

Left: Ivo Kohler with the inverted glasses. Right: Theodor Erismann as seen through the glasses.



5. Haptic feedback and flying: The previous environment darkened, and the participant's avatars were invisible again. The researcher communicated with the participant to take the controllers from their hands and introduce a chair to the participant's physical space.

16 This experiment involves a pair of glasses equipped with prisms that interchange up with down and right with left. This experiment is not the same as Ndinguwe, but it requires a similar cognitive performance. See also: „Theodor Erismann - Zentrum für Geschichte der Psychologie", accessed October 05, 2023, https://www.uni-wuerzburg.de/zgp/archiv/film-fotoarchiv/theodor-erismann/

The controllers were affixed to a "Hex Ball XXL" by a protective cover with rubber bands and cable ties. The participant was told that they had to catch a ball again. The Hex Ball XXL was thrown to them physically and was tracked and represented in the virtual environment in real time. Soon a 3D representation of a chair appeared in the virtual environment in the place matching its position in the participant's physical space. Two chairs appeared, one a green transparent scheme of the chair and one a physical wooden chair. The wooden chair was also equipped with a controller to track and display its position accurately in VR. When the participant placed the wooden chair in the place of transparent green chair, a countdown started. Participants were then asked to take a seat in the chair. After sitting they had sat down, a flight through virtual Dortmund began. It was accompanied by a poetic text of the voiceover, while the chair flew upwards through a decaying landscape. The virtual environment disappeared in a bright light, and the participants' view returned to MR.

Steffen looks down on the virtual city while flying.

MR outro: In the last scene, the participants returned to MR. Suddenly, a crow appeared and flew towards the players in a similar way to the balls before. This was to test if the haptic feedback had changed their perception of the virtual objects. The participant's changed perspective was inferred from differences in their behavior towards virtual objects flying towards them. The outro was used to provide a retrospective reflection of the experience for the participant. The headset was removed and the experiment ended.

Methodology of the implementations

During the experiment, the experimenter conducted the survey with the participants directly while experiencing the different scenarios. Initially, each actor read aloud the randomized virtual code number he/she

was assigned at the beginning of the experiment. This gave each evaluation a unique chronological index number and an individual code number. A questionnaire was used to ask the participants about their experiences with the application. Here are some of the questions used:

How is your body feeling? How do you experience the mixture of reality and VR (MR)? How do you experience the contacts with the virtual objects? How do you experience the virtual body (missing arm, age, skin color)? How do you understand the text? How do you describe your relationship to the avatars (empathy, defense, identification)? How do you experience your environment? How do you experience the game with your virtual double? How do you experience the haptic feedback? Please describe how you experience the flight.
At the end, the *participants* were asked a few retrospective questions: *How did you experience the journey? How would you describe your relationship to the avatars? Could you identify a narrative? Is there anything that will stay with you?*

The same questions were not always used; rather, the specific situations of the various participants were addressed individually. Over time, the interviews were reduced to simply asking them to report on their experiences, while the investigator occasionally offered suggestions. This method developed during the process and retrospectively proved to be less disruptive and more fruitful in terms of the individual quality of the statements. Unfortunately, there was a camera failure during the exterior shot of Natalie and damage during the first-person perspectives of Zahra and Christian H. due to discharged batteries. The damaged recordings were able to be restored with image errors (glitches) and used for appraisal (see video link).

Christian H. with image errors in the MR display, but he did not see them during the experience.

Behavioral studies

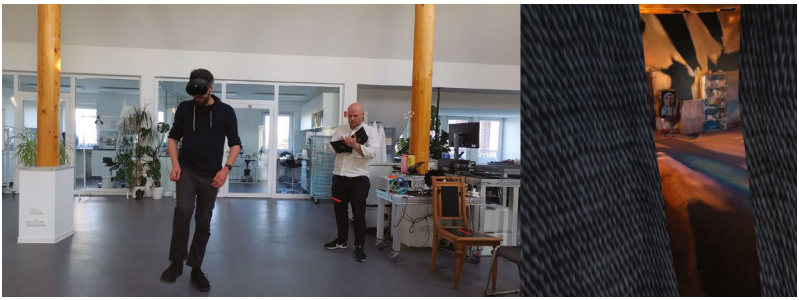
The participants described the touching of the portal in the MR intro occasionally as a feeling of electric *"tingle"* in the fingertips. However, such statements tended to be the exception. Furthermore, this effect occurred more frequently in participants who had infrequent to no prior VR experience. The doctoral students could not describe such an effect and described instead as a gesture they performed in empty space. When the gait of Montepulciano approached the participants, this was positively received and not perceived as problematic, although proprioception and visual flow were opposites. Often it was even described as pleasant, because the participants did not have to move themselves but still progressed, *"similar to a moving walkway at the airport or a train ride."* However, the comparison to moving walkways or trains is deceptive, especially from a perspective point of view: On a train ride, the static subject moves with the carriage while the surroundings pass by. In this experiment, the subject stands statically in the environment while the virtual object passes by the participants. The effect may be similar, but the relationship of the object to the background changes, resulting in different parallactic effects; a visual difference we do not find in the real environment. The holes in the virtual environment, which reveal the view of the environment, were partly perceived as errors, but also often used as a reference for one's own body sensation. So, Georg and Somi said hello as they drove by and Somi said, *"Here is a hole, so I can see you."* Individual participants described entering the virtual tunnel as a layer that interposed itself between and overlaid their perception of the environment and their own cognitive notion of the environment. Most of the participants experienced this with expectant excitement and their attention was almost continuously focused on the virtual image layer, although it was not physically real. The narrative text level mostly disappeared in the perception in the background noise of the interactive experience.

Somi looks through a hole in the MR.

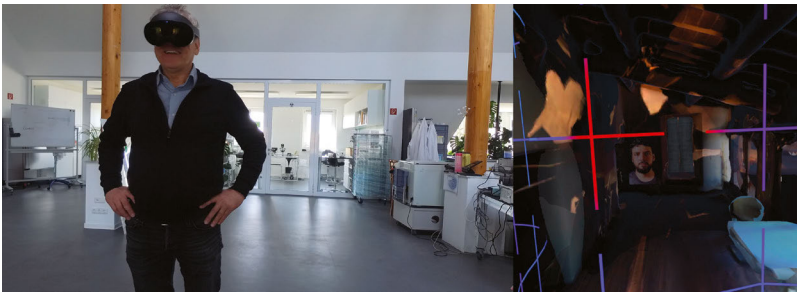
The straight line of Montepulciano

The particularity of the evaluation with the doctoral students was their knowledge of the corridor of Montepulciano, which was completely unknown to the other participants. It was often described as a café or, due to the moving movement, as a treadmill. However, for the PhD students this place in Montepulciano was a space filled with memories, where we discussed, experimented, thought, and acted. This space was considered the starting point of this experiment, which was why it was taken up intermedial. The doctoral students gladly accepted this offer of perception and identified the photogrammetric scan as the known location. It was observed that memories of the previous experiment were awakened. Somi said: *"And now I see the environment of Montepulciano. It comes over me."* She looked to the ground, perhaps searching for the line that provided guidance to the doctoral students in the Montepulciano experiment. Therefore, Steffen took a slightly stooped protective posture to avoid hitting his head on the ceiling struts again, as he had previously done. On the other hand, Zahra faced difficulties reconciling the overlap of the two spaces: *"It is so weird I am in Montepulciano and at the same time I am in Cologne. [...] it is like a time travelling."* Natalie described the feeling as follows: *"The room drives into my shins. It's a bit like in 'Stranger Things' because I know the room for real."* The physical experiences were again very present with Steffen:

> *It is strange for me because I know it, it is a strange experience of familiarity. (Makes a movement as if he is going up the step when passing through the curtain)." Ultimately, Christian H. remarked on the experience: "Sure things have come up again, so memories of Montepulciano, but especially of the events where I had the glasses on there. Otherwise, no other memories; so only of the walk. It was the same as in your experiment, just a bit extended.*



Steffen climbs the remembered step.



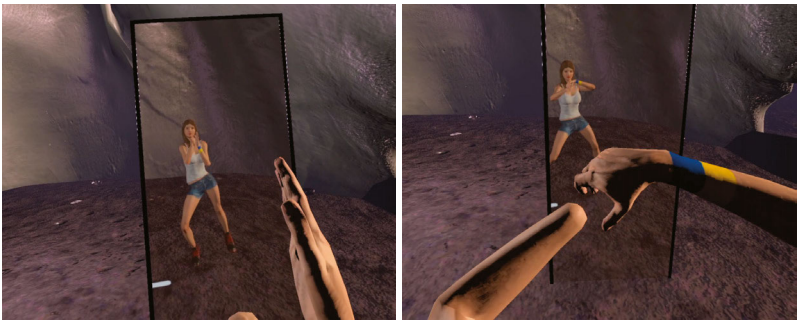
Georg drives around the room.

Identification with the avatars

The body experience with the avatars was considered exciting and curiously explored by most of the participants. The passive interaction in front of the mirror led to an intensive process of self-perception. With the setting of the mirror room, the potentials of identification, empathy, or rejection with the avatars *(the quasi-other)* were tested primarily. The reactions show a highly different relations to the virtual embodiments. The word "identification" comes from the Latin roots *identitas* "entity" and *facere* "to make" and is essentially used in psychology to describe the empathy of a subject with another person. According to this, identification, phenomenologically seen, is an observation of the foreign or the unfamiliar, which is brought into a comparison with the own self. Willingness to empathize is often synonymous with accepting the stranger into one's own self. When empathizing, stories are experienced from the first-person perspective, but that does not mean that one's persona is in danger of being displaced. In any case, this fear was not confirmed in the survey of the doctoral students, but defensive reactions nevertheless occurred in some cases.

Georg answered the question of identification with a half-state of identity as follows: *"With the avatars, one built up something like a half-identity. You've already noticed that it has something to do with you. Something irritating, something in between. You weren't just someone else, you could look at the hands. I didn't have a defensive reaction, but an irritation. I could not establish an identification. So, the stories that were told had nothing to do with me, they were the stories of these avatars, but not mine."* Christian R. described the condition similarly: *"It's not like looking at yourself in the mirror but standing by a person and looking at them in the mirror. I do feel identification, otherwise I wouldn't look at why I'm missing a shoe or why I'm missing a hand. So, there is an identification, but cognitively you know that this is not my reflection."* When we interpret Christian's R., it should be noted that he used identification in the sense of identity, meaning "to spatialize localize." Participants' own hand movements were identified in the foreign mirror image. Here the participants placed themselves in an accompanying relationship with the avatars. The content of the auditory narration was not reflected, but the attention goes to the visual perception, which was partly attributed by the participants themselves to the rare use of this medium. On the contrary, Somi became very empathically involved with the avatars and spoke about them in the third person as well as the first person: *"It is strange, when I look at myself. My clothes are changing, and I don't have any hand. Oh God, my gosh, I am handicapped. It is a really strange feeling, Tobias. The guy had a very strange style, but this woman, she is extreme, she had no hand. (She follows the arrows for one more round.) I see that my clothes are changing."* It is interesting that Somi spoke of her own clothes when she looked at herself and of *"the people"* when she looked in the mirror. Somi was able to establish the most intense relationship with the story of the woman without a hand because the idea of this impairment touched her, but at the same time she connected with the narrative. By contrast, Zahra felt a heightened impulse of defensiveness, even if it related more to visual self-perception than to narrative: *"This is the first time I see myself without a hand. Oh my God! I can't believe this, that I don't have a hand. I don't know why. I can see it, but I can't believe it."* However, Natalie dealt with the perceptual offer in a playful way: *"The strangest thing to me is*

this step and not having a hand. (Claps hands). [...] I automatically make a fist without a hand." By "step," Natalie referred to the size difference of the avatar, but probably also a technical faulty detection of the ground by the sensors. A similar detection and display error also occurred with Somi. In relation to the avatar, they were represented smaller in their height, which otherwise occurs only in children. Nevertheless, Natalie was not deterred and playfully tried out the possibilities and contradictions of the artificial restriction. Christian H. describes these grotesque motion sequences of the *quasi-other* as follows: *"Quite funny is that the leg movements behave like aliens, as you know them from science fiction movies."*



A playful way for Natalie to deal with the handicap with clapping and groping.

In the end, Christian H. very honestly described his reaction to the avatars as well as the setting as a whole as follows: *"There is an absolute defensiveness there because something is happening to you that you don't know and that you don't have any idea about. Because you have a complete relinquishment of control. And sure, then comes such a defensiveness. Somehow accepting that something like that exists, that something like that is possible. Which would probably be over by the next time or the time after that. The first time, there is already a lot of skepticism. I don't know if I really want that."* However, contrary to defenses, there were also more random factors (side effects) that further enhanced the experience. This was the case with Steffen when he wore the old man's avatar and grabbed his wrist. In doing so, his hand came to a stop at his watch, and he described touching the old man's hospital bracelet as follows: *"It's a very strange feeling right now because this band is right where my watch is. So, I'm almost like a little bit scared right now when I touched it."* Such moments are very immersive and can create the

illusion for fractions of a second that the visual deception is real, even if Steffen did not claim that for himself. Natalie, on the other hand, empathically engaged with the characters and listened intently to their stories. Throughout the evaluations, occasional imaginaries could be observed, which sometimes becoming physical. For example, Natalie described a strange perception during the story of the police murder of Mouhamed Dramé in *Dortmund*,[17] Germany: *"(Runs through the arch, the figure changes) This moment is totally crass, when you go through it. Then the body becomes so different. [Pause] Oh, I'm bleeding, I think, here. (She looks for a wound on her fingers) The text is already crass."* The fact that Natalie is looking for blood on her hand is indicative of her sensation of intense immersion.

The avatar of Christians is changing.

Natalie is searching for a wound on the hand.

Behavior in front of the real mirror

The MR sequence in front of the real and the virtual mirrors was also perceived as intense. The participants saw their own bodies overlaid by the avatar, which gave them the opportunity to compare their virtual reflection with their physical reflection. However, the participants were not informed that the time they spent with the respective figures in the mirror room influenced the assignment of their avatar. Thus, speculation arose as to the respective allocation. At the same time, Somi, who passed through the mirror room during her last run, was convinced that she was wearing the African avatar because she had passed through the self-image with him. She made the following comments: *"Because I have passed the mirror? The only time I go through the mirror is when I see this guy, so I think I represent him through that. Several times I was a different persona, then I went through one to explore the mirror world and then I was*

17 David Peters, „Tödliche Schüsse auf Mouhamed Dramé: Anklage gegen fünf Polizeikräfte", accessed February, 2023, https://www1.wdr.de/nachrichten/ruhrgebiet/anklagen-fall-mouhamed-100.html

here, now everything is black." Zahra, on the other hand, consequent held to her self-image and said: *"The thing is, I know who I am, to my reaction I see somebody else in the mirror. Very weird. Who are you (she asks her mirror reflection)?"* Zahra connected with the *quasi-other* in this way, intending to make her false mirror image a separate entity by addressing it. Christian H. also continued to lean towards his defensive posture and tried to separate a physical difference: *"You kind of try to build up a defensiveness, also I do. You hold on to what you know. I do not completely succeed, however. The play with the different mirror images is beautiful. It is a mixture of fascination and ambivalent feelings."* Georg, Natalie and Christian R. were primarily engaged in observation of their virtual bodies. By contrast, Steffen explored the room more and discovered a poem on the back behind the mirror: *"Good mirrors are not cheap."*[18] At the end, Christian H., Zahra and Steffen embodied the young man with tailcoat, Somi the African refugee, Natalie the old man and Georg and Christian R. the young woman without one hand.

Georg observes the superimposition of his own body with the avatar and sees the physical difference of the missing hand.

Ball interaction

The interaction of the doctoral students depended on the character they virtually embodied. Natalie jokingly said, "But I'm an old man. I can't do this." She also perceived the increase in the frequency of ball shots almost physically and expressed herself with expressions of pain such as, *"Aua! This is worse than dodgeball."* Natalie was visibly stressed and frustrated, which may have been a result of the high frequency of shots. Nevertheless, the constitution of the virtual body was of relevance for the ball interaction of the participants. It

18 Eve, "Poetic Medicine: Good Mirrors Are Not Cheap," Poetic Medicine (blog), 19. März 2010, https://poetrypill.blogspot.com/2010/03/good-mirrors-are-not-cheap.html

was remarkable that Georg as well as Christian R., who were both embodied by the woman without the left hand, predominantly use their right hand to block the balls. However, as the frequency of the ball's increased, their use of their left hand increased. Georg reacted to the greater ball frequency by dodging instead of defending. The self-embodiment of the participants seemed to have an impact on the interaction strategies with the environment. Most participants were right-handed and therefore mainly used their right arm. Nevertheless, many tend to strike a volleyball postured in such situations. In addition, evaluations with left-handers have also shown that they use the right hand (you can read about this in the following article). Not every actor will necessarily use the right hand, but the optical self-perception prefigures the strategy of action. In general, the contact with the ball was not perceived as haptic but as interactive.

Somi struggles with a high ball striking rate.

Behavior with the double

At the beginning of this scene, the participants were asked by an off-screen voice: *"Can you pass a few balls with your double?"* To which Somi responded in German: *"Ja, ich kann (Yes I can). I see the guy visible, it's me."* This reaction showed that Somi had now accepted her avatar as a virtual self-representation (the *quasi-other*). By contrast, Zahra continued to deny this: *"You know, I accept the places where I am in, but I don't accept that I see myself as somebody else. I don't know why."* The experience with the double triggered general confusion at first. Steffen described his experience as follows: *"(hits the ball with right to the double, but then lifts the wrong arm for the double). I can't really tell; I can see what I'm doing wrong."* Christian R. remarked in this regard, *"That's difficult. It doesn't move like my reflection."* Christian H. remarked: *"He doesn't do what I want.*

It's hard with the right/left." Georg, on the other hand, quickly found a strategic way of dealing with the situation to maximize his chances of success. He came close to the figure, bringing both hands into a static, equal posture, thereby canceling the aspect ratio right and left and mechanically moved his upper body. Nevertheless, none of the participants managed to pass the ball back and forth once. It remains to be noted that when we experience a self-embodiment in the environment, our brain is conditioned to perceive it as a mirror image.

Christian R. interprets the pages the other way around.

Haptic feedback and flying through the virtual city

In the next scene, the virtual ball became the physical representation of a "Hex Ball XXL" that could be played with. Georg said in this context: *"The haptic feedback absolutely increases the immersion. Absolutely enhances reality."* (Throws the ball to his remote-controlled self) Somi felt similarly about this state of affairs and described it as follows: *"Aha, yes, it's, nice it's completely imaginable - that's my ball, because it is in the dimension completely comparable with the thing that I see here."* For Christian R., this direct comparability was only limited: *"There's the conflict again now. The ball that you see has a round surface. The ball you feel, of course not, because the ball has the holes, this structure."* Steffen also perceived this discrepancy: *"It's a very weird feeling for me; it seems so massive, but I can reach through. I like the synchronous spinning of the ball."* Natalie remained focused on haptics: *"That's really crazy. It wobbles a little bit like the jellys I often work with. Yes. (Rolls the ball across the floor) That worked totally well."* Christian H. remained skeptical about the handling of the virtual environment even after haptic feedback: *"Too bad I saw the ball already, before that. (The ball is thrown and caught the second time.) The haptic contact with the real world doesn't really*

work for me." Nevertheless, just like the others, he managed to throw some balls to himself with the invisible playing partner. This made it clear that the participants had no problem catching the ball despite the invisibility of their own bodies. In this case, proprioceptive self-awareness was independent of visual perception.

An invisible person gives Somi a ball.

After the ball game, a physically represented chair appears that can be moved around the room. If the participants placed the movable chair in an immovable green silhouette of the chair, a countdown started. Christian R. described this situation as follows: *"I see the chair. I'll put it here with the green chair. (He sits down on the chair) Now that's stranger than walking, where the room moved. Yes, this is already a feeling of flying, as I imagine it."* By contrast, Steffen initially accepted the situation less intuitively: *"Intense is a nice word for what I feel. I feel the need to touch the legs of the chair from below. I notice that I feel less dizziness than I would have thought before it started. But this fixed point (chair), even if I don't look at it anymore, but I still feel it, is a stabilizing help."* According to this, haptic feedback changed the relationship with the virtual environment on several levels. The proprioception – in combination with the visual perception – could be influenced by the haptics, and the illusion of half-flying was created. It was observed that the perception of the narration from off-screen in the sitting position received more attention. Thus, Somi commented on the situation as follows: *"(Talks with the voiceover) Access to what? Ah ok an exit. Access or exit? Where we wanna go? I am dead now, because it is completely white."* The observation that the sitting position favored listening was also made with some other participants outside of the observation with the doctoral students.

Somi holds the ball as it flies, which dissolves into glistening light.

Return to MR

In the last part, primarily retrospective questions were asked about the experience, with the primary aim of checking which events might solidify as memories. During the questioning, after some time, a bird appeared and flew towards the head of the actor. This was to test whether haptic feedback changes the physical presence of other virtual objects. Typically, participants dodged the bird if it was noticed. However, according to the participants this could not be attributed to a feared collision with the bird but rather the natural reaction of wanting to avoid an imminent collision. Somi noticed the bird with the following words: *"Wow that is strange (The bird appears) there is coming something and fly on my head. You know there is a crow."* Steffen mentioned during the interview that the experience of confusing the arm band with his watch will have a lasting effect on him. Zahra ultimately wanted to clarify: *"Nothing about myself was true,"* which clearly shows the difference between the two worlds. For Georg, on the other hand, the voiceover was significant: *"Very important in this, is the voice that grounds you and makes you feel lifted up. (Dodges the bird.)"* He noted that if he were to do another run-through, he would pay even more attention to narration than perception. By contrast, Christian H. saw the possible risks that such a technique entails: *"I grew up with people who were out and about in the city during the day and suddenly saw a crosshair in front of them because they were just gambling. [...] But you need completely new strategies to prepare the little people (children), who can't even cope with reality, for that."* The experience was one of ups and downs for Natalie: *"The feeling of stress will stay in my memory, but also the success of being able to physically catch the ball afterwards. That built me up again. I'm not just at the mercy, I'm able to take action."*

The bird flies towards Somi in the MR outro.

Discussion

The research question posed at the beginning, how the participants aligned their personal space of experience with the experiences in the virtual world, can be answered to the effect that the integration takes place in different stages depending on the user: there is 1) no coherence, 2) a partial coherence, or 3) an approximate coherence with known experiences.[19] If there is no coherence, the experiences are mostly perceived as irritation or error because they cannot be integrated into structures guided by the imagination (e.g. the virtual ball flies through the participants). In the case of partial coherence, ambiguous interactions occur, which partially produce effects in which the brain tries to compensate for the experience difference and thus causes hallucinations (disembodied contacts are felt; illusion of seeing blood). In the case of approximate coherence, irritations are accepted, and differentiation is subjectively difficult. A form of multimodal perception emerges (net structure of the ball is accepted despite the optic difference; haptics increases confidence in the virtual environment). Unknown experiences are therefore integrated into known ones by reference to them. The evaluation with the doctoral students showed that the place is recognized as Montepulciano. Memories of a specific experience are reactivated, and physical handling patterns (ducking the head, readiness to catch the ball) are also recalled. This memory layer can activate different memories than a photograph could due to the spatial topology

19 Mel Slater and colleagues has developed a definition (coherence is defined as the set of reasonable circumstances that can be demonstrated by the scenario without introducing unreasonable circumstances, where a reasonable circumstance is a state of affairs in a virtual scenario that is self-evident given prior knowledge) of coherence and three factors to contribute plausibility: 1) the reactivity of the environment to participant actions, 2) contingent references by elements of the environment to the participant, and 3) credibility of expectatio, i.e. the environment is constructed based on evidence of what is supposed to happen in real life where this is relevant, so that the application is supposed to be a simulation of events that occur in reality. Cf. Mel Slater u. a., "A Separate Reality: An Update on Place Illusion and Plausibility in Virtual Reality," Frontiers in Virtual Reality 3 (27. Juni 2022): 10, https://doi.org/10.3389/frvir.2022.914392

of the photogrammetric scan. Acting in these memory spaces does not correspond to acting but to acting in one's own virtual world of experience.[20] This fact has been successfully used for some time in trauma therapy[21] – for example – to treat traumatic experiences through virtual recapitulation. This effect can also be used narratologically, but these virtual places are exclusive. To use the feeling of a personal memory, either public places must be chosen or exclusive individual productions have to be created, which would make this attractive only for a smaller circle of participants.

The interaction with the avatars shows that the half-identity allows for a confrontation with the alien self, whereby the participants can react either insituatively or extituatively, i.e. either they playfully let themselves in or they reject it. Both reactions create an expanded sense of self-awareness. The technically simulated self-perception can be described with Ihde's words of the *quasi-other*. This shows that the acceptance of the mirror image as an unknown technical self-portrait is lower than when the participants only see their virtual hands. In this regard, the philosopher Tom Poljanšek, following the phenomenologists Johann Friedrich Herbart and Edmund Husserl, speaks of apperception.[22] By this, he means the process of *Hinzu-wahrnehmens* (*adding-perceiving*/translated by the author), i.e. the addition of perceptions. This is what happened to the participants when they suddenly wore an avatar. The inner monologues of the avatars, on the other hand, are less relevant and are only perceived with attention when they are of interest. As soon as the participants were no longer spectators but participants, they wanted to act and only take on the attitude of the listener to a limited extent. Identification can therefore only be generated in the sense of "locating" the self-representation and not in the sense of transferring a persona. The degree of empathy depends on the ability to get involved. The example with Steffen's watch clearly shows that

20 Cf. The philosopher Alva Noë describes the subjective world of experience as virtual, into which only those things enter that our consciousness has grasped. Their cognitive representation is thereby linked to a content (something recognized) and becomes a virtual object of the world of experience through interaction. Alva Noë, Action in Perception, Illustrated Edition (Cambridge, Mass.: Bradford Books, 2006), 215–16.

21 Cf. Jeremy Bailenson, Experience on demand: what virtual reality is, how it works, and what it can do, First edition (New York: W. W. Norton & Company, Inc, 2018).

22 Cf. Tom Poljanšek, „Nie ganz bei den Sachen", in Technik-Ästhetik: zur Theorie techno-ästhetischer Realität, hg. von Oliver Ruf und Lars Christian Grabbe, Medien- und Gestaltungsästhetik 12 (Bielefeld: transcript, 2022), 183. In this paper, the terminologies insituative or exsituative, as well as apperception are detailed in relation to immersion.

the effects of reality hybridizations cannot be artificially produced so far since they only arise through unexpected sensual analogies. The unknown is necessary for this. Such an effect can only occur if no classification of the experience takes place through the experience. The ball game showed that provoking a stressful situation results in discomfort but not cancellation. Nevertheless, physical reactions such as cries of pain or evasive reactions resulted, although it would have been sufficient to close the eyes to escape the optical bombardment. The haptic feedback, on the other hand, meant a clear increase in immersion. It turns what is seen into something material, even if it does not meet the expectations of haptics. The flight on the chair becomes more real because it has a physical basis. Here, the participants reverted from the state of the actor to the attitude of the spectator. The flight on the chair became more real because it had a physical basis. Accordingly, more of the narrative was perceived in this last phase. Overall, it remains to be noted that narration takes a backseat to interaction. For the narration to be received, according to the current state of knowledge, either the willingness of the participants must exist, or it must be stimulated (e.g. by reducing the possibilities for interaction). It is important to activate the inner attitude as a spectator or listener. This can succeed as soon as the personal lifeworld is stimulated on different levels. An attempt to category these levels follows.

Postphenomenological classification

The descriptions of the participants clearly show that each of them is sensitized to his or her own pattern of perceptions due to the *lifeworld* from which he or she lives and that the personal *lifeworld* influences the experience. For this reason, a costume designer from the theater reads the virtual skin of the avatars as a kind of costume in whose structure traces of a story can be read. Athletes recognize in the ball game with the invisible the potential for a new training method in which one must read from the behavior of the ball and not the ball player. The entire virtual experience functions as a mirror of one's own life world, which can show one how one's own thinking is structured.

The results make it clear that even before microperception, certain expectations of the environment exist that are derived from

the respective world of experience. It is expected that you can grab the ball, that you bump your head on a frame, that the ball should fall if you drop it. If these expectations are disturbed, not confirmed, or even break with known experiences, besides disbelief and irritation, contact with the unknown arises resulting in a moment of doubt and the idea of another reality behind the visually apparent. The initially named scheme of technologically mediated world relations of *alterity relation* by Don Ihde does not quite live up to its own claim of clear differentiation in the case of an HMD-based VR installation. It only captures the difference between the technological world and the real world in an inadequate way. The *quasi-other* describes the phenomenological difference, but it does not include the level of adding-perceiving. For this reason, the technology philosophers Robert Rosenberger and Peter-Paul Verbeek developed the *immersive relation,* which clearly shows the difference between the HMD-based and subjectively experienced worlds:

(I - Technology) ⟶ World MR
↘ (Technology – World) VR

In this scheme, the brackets are seen as a unit in which the "I" is connected to the technology (indicated by the hyphen). At the top, this unity connects the subject with the technology, where the world can be seen embedded in a MR, for example. With the downward arrow, a technically represented world is seen that visually overlays the environment. Rosenberger and Verbeek justify this as follows:

> *When using Google Glass, people both have an embodiment relation with the Glass itself, and a hermeneutic relation with its screen that offers a representation of the world. Therefore, it offers not one, but two parallel relations with the world. The intentionality involved in such "augmentation relations" can be indicated as "bifurcated": there is a split in people's directedness at the world, because two parallel fields of attention emerge.*[23]

This could also be what Zahra means when she said she is in Montepulciano and in Cologne at the same time, or what Georg meant when he talked about half-identities. This means that the downward arrow refers to the extension or overlay of the actual reality.

23 Robert Rosenberger and Peter-Paul Verbeek, Hrsg., Postphenomenological investigations: essays on human-technology relations, Postphenomenology and the philosophy of technology (Lanham: Lexington Books, 2015), 22.

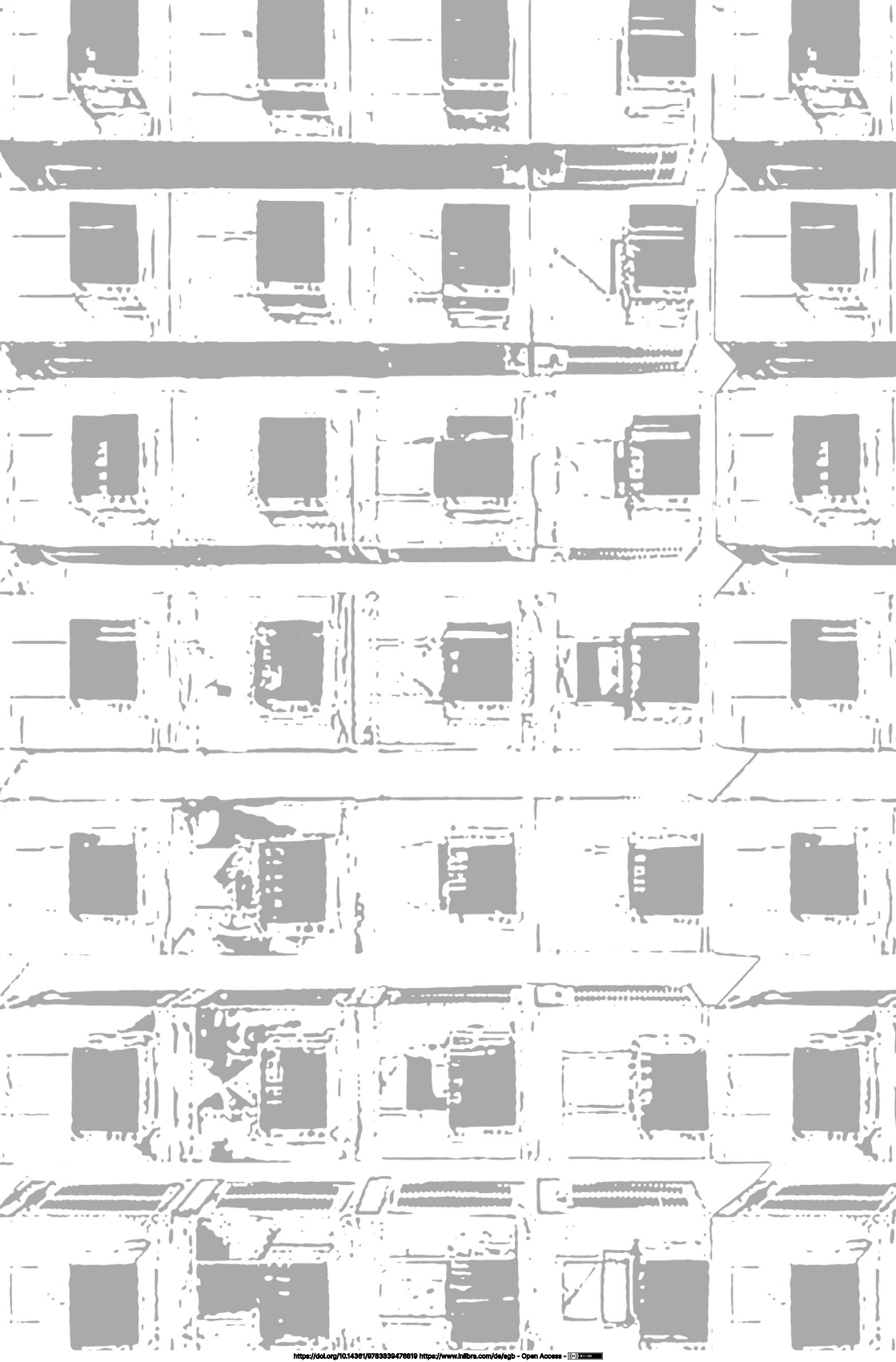
However, this split leads at the same time to a divided attention, since both worlds are thought in parallel (which similarly describes Tom Poljanšek's thesis of apperception). The special thing about the *immersion relation* is that it can partially simulate the other relations. Thus, an immersion relation may well represent the *embodiment, hermeneutic, alterity or background relation* on the level (technology-world). Due to the content of Ndinguwe, a computer-generated self-image and a computer-generated world emerge, which corresponds to Ihde's indicators of an *alterity relation*. However, the HMD itself can also be understood as an *embodiment relation,* since the glasses disappear from the conscious perception. The potential offered by the *immersion relation* is that both worlds in cognition eventually become an imaginary world again and thus also serve only a virtual world of experience.[24] This virtual world of experience can thus be expanded to include experiences that sensitize us, allows us to focus, create awareness, or enable experiences that would otherwise have remained inaccessible to perception. The potentials of these experiences are currently unknown to a strong extent and accordingly stimulate the imagination of possible applications.

Further outlook

This is a first partial evaluation of Ndinguwe's results. However, as this is only a fraction of the assessments collected, further evaluation will take place. There is an increased focus on physical reactions, but also on the potentials of narration. The spectrum of evaluated participants includes different groups of people. The experiment was conducted with children, directors, professors, athletes, teachers, designers, sociologists, students, VR professionals (Places), museum curators, and transvestites. This broad field of lifeworlds shows a wide variety of ways of looking at Ndinguwe and thus makes diverse ways of reading visible. There were many different reactions. These reactions offer hints for further experimental investigations in which 1) the relation of interaction and narration, 2) the movement behavior of the participants in the virtual space, 3) connections between real and virtual scenes, 4) habituation effects, 5) identifications, 6) interactions and 7) technical precision can be examined. This evidence will be explored in further detail in

24 Noe, Action in Perception.

a further evaluation. A follow-up experiment would bring the relationship between multi-linear narration and interaction into greater focus. Finally, referring to the experiment in Montepulciano, it remains to be noted that the shadow play in Plato's cave always takes place as soon as we assume the position of a viewer. The moment we start to act, the narratives disappear in the background, and decision-making becomes essential.



Everything I had been firmly convinced of, everything I had relied on, was blown away by the wind. I felt that I understood something. Without thinking about it, words came out of my mouth: »There is nothing at all in this world…« I felt that I understood nothing. (Editor's note: To understand nothing in this sense means to recognize the inadequacy of intellectual knowledge.)

Masanobu Fukuoka[1]

Mattis Kuhn

As Far as I Don't Know
Aesthetic experience as diffraction apparatus

Traces of the aesthetic

I walked through a group exhibition, registering the individual works without any aesthetic play taking place. The works did not spark my imagination to go beyond the sensory impressions, until I saw a work – »El agua en la ciudad« (2004) by Mexican artist Teresa Margolles – that made an impact on me even from a distance. On a screen hung in the room was a grayscale video, whose center was filled with a corpse lying in state. While this alone was not the crucial point, the decisive factor was the rising steam created by the hot water used to clean the body. This was done by a person standing behind the table with the help of a hose, protected by an apron, with their head out of the frame. What irritated me was that as the body lay there being hosed down with hot water, it looked so alive to me. In my imagination, the person lying there should have immediately jumped up in pain, but he didn't move. Of course, the reason for this was clear to me and could have calmed me down, but the images kept creating the impression of a body that would wake up at any moment and jump up screaming. By contrast, the apron and the casualness with which the person held the hose gave the impression that it was not a human body at all, but could just as easily be a slaughtered animal or a car being washed.

1 Masanobu Fukuoka, *Der Große Weg hat kein Tor* (1975; repr., Darmstadt: pala-verlag, 2021), 33 f. *All quotations, apart from those by Karen Barad, Giorgio Agamben and Neo Rauch have been translated by the author.

Part of the installation is a bench made out of concrete for the viewer (»Banco«, 2004). The concrete was made with the water used to clean the corpse. The bench on which the viewer sits actually contains traces of the dead body, which are now inseparable from the concrete. The bench on which I sit bears traces of past life and I think about how much life and death our civilization is and will be built on. I also wonder what will happen to the organisms in the dead human body and whether it will be a breeding ground for new organisms while others lose their habitat. I am thinking of our treatment of water and the many pollutants that end up in it and are then reabsorbed by organisms (and ourselves). The materiality of the bench cannot affect me to this extent on its own. I have to know and believe the artist that the wash water has been worked into the bench.

Aesthetic thinking

The previous sections are a description of sensory impressions and their linguistic reflection. Christoph Menke describes these two phases as "aesthetic watching" and "discursive reporting."[2] Theory is "the exposure to watching and the return and reporting on this watching." "Theory is divided in itself – into aesthetic watching and discursive reporting or articulation."[3] Aesthetic watching is linked to pathos – "suffering" or "being touched"[4] – from which the watcher emerges through the process of reporting. In the experience of the exhibition visit described at the beginning, the "aesthetic watching" of »El agua en la ciudad« evoked a feeling of being touched, a resonance in me, and ultimately moved me to report on it, first to myself, and now here. By stepping out of aesthetic watching and into reflection, subjectivity is constituted:

> *There is subjectivity only in the break with the aesthetic state. If theory – in the second step – is the going beyond aesthetic watching, which it was – in the first step – then theory is therefore the condition of subjectivity. The theoretical break with aesthetic watching is the act of the subject's self-constitution. Every subject is theoretical: it was a theates, an aesthetic spectator who has placed himself out of this state by beginning to speak about it.*[5]

2 Christoph Menke, *Die Kraft der Kunst* (Berlin: Suhrkamp, 2013), 122.
3 Ibid. 123.
4 Ibid. 120, 126.
5 Ibid. 126.

»El agua en la ciudad« is the only work from the exhibition that I still remember today and that can still evoke aesthetic thinking in me. By describing the work now, years later, it still (or again) produces an effect on me and I can create new perspectives together with it without having to have it in front of my eyes. Now that it seems to be becoming the norm that human lives are brutally extinguished every day all over the world, in the image of the corpse being washed (presumably impassively) by another human being I see a luxury that many people are denied.

If aesthetic experiences are measured by their effect, many things are probably not aesthetic things in this strict sense for the respective subject. Only a few produce strong effects that trigger aesthetic thinking. However, these are not the same things for everyone, so that these also have their right to exist, which leave no traces in myself.

Intra-actions [relational ontology]

The fact that works of art can produce different effects in people and lead to very different descriptions of their experience is essentially facilitated by their relational and negative ontology (which will be discussed again later). Relational ontology has been present in art in the form of the *open* work since the mid-20th century at the latest, especially from the 1960s onwards. Open works of art replaced the concept of *closed* works in the sense of the »aesthetics of truth«.[6] They are open in terms of their physical object boundaries and their boundaries to non-art, and they are also characterized by a fundamental openness of meaning or indeterminacy towards interpreting subjects. This also meant an emancipation from the belief that (aesthetic) properties lie in the things themselves, which make them works of art independent of interpreting subjects. On the other hand, things only attain their aesthetic existence in the constitutive act *with* the subject. Rüdiger Bubner summarizes this under the term »aesthetic experience«.[7]

6 According to Rüdiger Bubner, an aesthetic that assumes a truth placed in the work presupposes "the ontological location of the occurrence of truth outside of a theoretical context of thought." "An objective condition appears as a work, which has an independent existence beyond theory and reflection […]." Rüdiger Bubner, "Über einige Bedingungen gegenwärtiger Ästhetik," in Ästhetische Erfahrung (Frankfurt am Main: Suhrkamp, 1989), 32.

7 Bubner, "Über einige Bedingungen gegenwärtiger Ästhetik."

> *In no picture can you simply see what the viewer sees in it, in no poem can you definitely read what one reads in it, and in no piece of music is it enough to listen carefully to hear what is expressed in the aesthetic experience. [...] The aesthetic experience sees something that it cannot pin down and that is therefore always there.*[8]

Parallels can be drawn between the characteristics of aesthetic experiences presented thus far and the framework of agential realism formulated by Karen Barad.[9] This attempts to provide a comprehensive explanatory model for the analysis of reality, which can be applied in various disciplines. For example, it is negotiated as a model for human-machine "intra-actions" in HCI research[10] or applied in media theory.[11] In addition to the parallels with aesthetic experience, differences are also highlighted that represent an extension of agential realism.

Similar to art, agential realism is also based on a relational ontology: "relational ontology [...] is at the core of agential realism."[12] Two central concepts of this relational ontology are that 1) things (including humans) have no inherent properties and 2) things (including humans) have no clear boundaries. On the contrary, properties and boundaries emerge in "intra-actions" of agencies. »Agency« refers to the act of shaping reality, or – in the framework of agential realism – the production of reality. Barad defines »intra-action« as follows:

> *The neologism »intra-action« signifies the mutual constitution of entangled agencies. That is, in contrast to the usual »interaction«, which assumes that there are separate individual agencies that precede their interaction, the notion of intra-action recognizes that distinct agencies do not precede, but rather emerge through, their intra-action.*[13]

One of the phenomena (»phenomena« emerge through intra-actions of agencies) analyzed in more detail by Barad is the ultrasound examination of an unborn child, in which interlocking and reality-configuring agencies emerge. To touch upon some aspects in brief: the examination assigns a gender to the fetus, which can lead

8 Ibid. 43.
9 Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Duke University Press, 2007).
10 Christopher Frauenberger, "Entanglement HCI The Next Wave?," ACM Trans. Comput.-Hum. Interact. 27, no. 1 (November 2019), https://doi.org/10.1145/3364998.
11 Exemplary Olga Moskatova, "Apparate des Sichtbaren. Neomaterialistische Zugänge zur Agentialität der Bilder," in Agency Postdigital. Verteilte Handlungsmächte in Medienwissenschaftlichen Forschungsfeldern, ed. Berenike Jung, Klaus Sachs-Hombach, and Lukas R.A. Wilde (Köln: Halem, 2021), 145–77.
12 Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning,* 93.
13 Ibid. 33.

to abortion due to different agencies such as the wishes of the mother or other people, social pressure, etc. On the other hand, the fetus can be assigned rights (agencies) and thus turn the mother from subject to object. However, the ultra-sound device is not objective and therefore does not always lead to the same results, but instead it is dependent on human operators and their interpretations as well as generally the setup in which it is used. Nevertheless, the resulting images are treated by us like photographs.[14] According to the relational ontology of agential realism, agency is not an attribute that can be possessed, but rather: "[A]gency is a matter of intra-acting; it is an enactment, not something that someone or something has. […] Agency is »doing« or »being« in its intra-activity."[15]

Using Barad's terms, aesthetic experience can be described as an entanglement that is created by the intra-action of – among other things – subject and object, whereby these in turn only emerge in this entanglement. Subject and object are therefore not independent, separable things, but are continuously constituted through intra-actions. It is therefore not *I* who interprets the (aesthetic) object, but rather an entanglement is realized in which many – above all socio-cultural – agencies participate. The object is not aesthetic per se. Whether something is aesthetic or not does not exist in itself, but rather it becomes aesthetic at the moment of aesthetic experience through the intra-action with the subject. The subject-object separation – and the hierarchies associated with it – is not determined and fixed from the outset, but is suspended in the entanglement of interacting agencies. Juliane Rebentisch formulates this with Bubner as follows:

> *Aesthetic experience does not, as the concept of experience might initially suggest, reside solely in the subject. It takes place between subject and object, and in a way that the former can never fully control. Not only the object, but also the subject of aesthetic experience is aesthetic only through and as its becoming-aesthetic. Both the subject and the object of aesthetic experience must be conceived in terms of the aesthetic experience that constitutes them and can therefore only be adequately understood in relation to one another.*[16]

14 Barad, chap. 5. This comparison is certainly no longer as strong as when Barad formulated it. Due to the increasing digital image processing (already in the process of capturing) and the increasing amount of generated image content (and the agencies associated with both), the comparison could also be reversed: photographs are becoming increasingly like ultrasound recordings.

15 Ibid. 178.

16 Juliane Rebentisch, *Theorien der Gegenwartskunst. Zur Einführung* (Hamburg: Junius, 2013), 51.

Apparatus: Matter and meaning

Agential realism is based on the epistemology formulated by physicist Niels Bohr for the interpretation of quantum physics. His reason for doing so was that the prevailing epistemology in Western science still corresponded to classical Newtonian physics and was therefore incompatible with quantum physics.[17] Put briefly, Bohr's epistemology is that through the instruments that we develop, we first define what can in principle be known about a thing. Through the measurements that are then actually carried out, properties are attributed to the thing within this delimited scope by means of language. What is said about a thing is therefore not inherent and objective in it, but rather dependent on instruments of knowledge production.[18] Barad adopts this epistemology and supplements it with an ontology (which – in her view – is only implicitly present in Bohr's writings) and a resulting ethics.[19]

According to agential realism, the question of place, time and in general measurable or assignable properties does not *reflect* inherent properties of the objects, but rather these *properties emerge* depending on and in the respective frame of reference – the »apparatus« – with and in which the measurement or attribution is made.[20] *My* height or my age are not inherent properties, but are defined by external scales and measuring devices, as well as other socio-cultural factors that are part of the apparatus. Attributions such as »young« or »old« are primarily evidence of a meritocracy shaped by capitalism (which thus performs various agencies) and its underlying ontology[21] and thus correspond less to physical, material

17 Barad describes what – in Bohr's view – would be necessary for adherence to Newtonian physics: "In other words, the assumptions entail a belief in representationalism (the independently determinate existence of words and things), the metaphysics of individualism (that the world is composed of individual entities with individually determinate boundaries and properties), and the intrinsic separability of knower and known (that measurements reveal the preexisting values of the properties of independently existing objects as separate from the measuring agencies)." Barad, Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning, 195.

18 Ibid, 19–21.

19 From the author's perspective, ethics remains strongly underexposed, which is why the focus of this text is on ontology and epistemology. For a critique of Barad's remarks on ethics, see Katharina Hoppe and Thomas Lemke, "Die Macht der Materie. Grundlagen und Grenzen des agentiellen Realismus von Karen Barad," SozW Soziale Welt 66, no. 3 (2015): 261–80, https://doi.org/10.5771/0038-6073-2015-3-261.

20 Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning,* 138 f. with reference to Bohr's »epistemological framework«.

21 Central dominant elements of the current structuring of the world are the drawing of boundaries and dualistic thinking. As a few examples: we see ourselves as clearly definable individuals with nameable properties (which exclude other properties); ascribe singular authorship to ourselves (as this article also appears under my name and yet would be a completely different one without the criticism and suggestions of Tobias Bieseke, Christian Heck, Leonie Hunter, Paul Kaletsch, Steffen Mitschelen, Christian Rust, Johanne Schröder, Georg Trogemann, Natalie Weinmann); dissect becoming through instruments such as time and calendars; and quantify and classify phenomena and judge primarily according to the dualistic principle (good or bad, win or lose, true or false, culture or nature, human or non-human, etc.).

reality. Measurements and attributions only become meaningful in a frame of reference with which they are defined interactively in "material-discursive boundary-making practices."[22] Foucault – to whom Barad refers here and for whose thinking the concept of the apparatus [»dispositif«] is central according to Giorgio Agamben – describes the term as follows:

> *What I'm trying to single out with this term is, first and foremost, a thoroughly heterogeneous set consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral, and philanthropic propositions – in short, the said as much as the unsaid. Such are the elements of the apparatus. The apparatus itself is the network that can be established between these elements…*[23]

Apparatuses can be constructed, although this construction only defines a controllable and tangible part rather than the entire apparatus, as this cannot be fully delimited. Barad explains this at the beginning with reference to setups for physical experiments (however, the term apparatus as well as the framework of agential realism are not limited to the natural sciences or measuring instruments). An obvious example of the arbitrary but also fleeting nature of an apparatus and thus of unplanned agency occurred in the experiments carried out in 1922 by the physicists Otto Stern and Walther Gerlach to demonstrate »space quantization«. After Gerlach had constructed the apparatus based on Stern's idea in iterative runs (the difference between the simplicity of the idea and its time-consuming material realization was great) and they carried out experiments, they initially regarded the attempt as a failure. A beam of silver atoms should have left a trace at specific points on a flange, but Gerlach could not see any traces and passed the flange on to Stern. He looked at the flange up close and slowly traces appeared. Stern consumed a considerable number of cigars, but due to his low income[24] he could only afford cheap ones that contained a high proportion of sulfur, which passed into his breath

22 Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning,* 93, 170.

23 Michel Foucault, *Power/Knowledge: Selected Interviews and Other Writings,* 1972–1977, ed. C. Gordon (New York: Pantheon Books, 1980), 194–96. Quoted by Giorgio Agamben, "What Is an Apparatus?," in What Is an Apparatus and Other Essays (Stanford: Stanford University Press, 2009), 2.

24 It is well known that it is not only income that is decisive, but even more so the existing or non-existing capital in all its forms and agencies. For example, Pierre Bourdieu distinguishes between economic capital (material possessions), cultural capital (education) and social capital (network). Aladin El-Mafaalani, Mythos Bildung. Die ungerechte Gesellschaft, ihr Bildungssystem und seine Zukunft (Köln: Kiepenheuer & Witsch, 2022), 26 f.

and transformed the silver on the flange into silver sulfide, which became visible.[25] Ultimately, his specific cigars proved to be a necessary component of the apparatus:

> *The reproducibility of the experiment depends on the cigar's presence. Not any old cigar will do: the high sulfur content of a cheap cigar is crucial. Class, nationalism, gender, and the politics of nationalism, among other variables, are all part of this apparatus (which is not to say that all relevant factors figure in the same way or with the same weight).*[26]

These are "difference[s] that make a difference."[27] In the 1960s, Joseph Kosuth developed a perspective on conceptual art according to which "the sensual medium is irrelevant as a condition of art." It was only about the content of the idea, the concept, the concept of art in general, etc., whereas the material realization was no longer relevant.[28] Kosuth wanted to provide (material) proof of this concept of art himself with his work »Art as Idea as Idea«, comprising prints of enlarged dictionary entries on abstract terms such as »definition«, »art«, »meaning« or »chair«. However, it was precisely their enlargement that produced material peculiarities in the typeface and the carrier medium, which distract from the abstract terms and can thus generate additional meanings.[29] Artifacts of art exemplify the ontological and epistemological view that meanings are not firmly anchored in things but are produced in discourse. With different interpreting/intra-acting subjects/objects, different entanglements emerge, i.e. including different discursive practices and thus different meanings. A variety of – also material – agencies are integrated into an aesthetic experience: the historicity (of art), the socio-cultural character of the interpreting subject, the current mood, spontaneous interests, the situation in which the aesthetic experience takes place, and much more. Aesthetic experiences extend beyond mere terminological thinking and can therefore be particularly influential. For example, when I talk about *non-human animals,* this is intended to break down

25 Barad criticizes the fact that the primacy of the visual over other senses has a major influence on epistemology. Barad, Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning, 86. The same applies to art, which (still) places a strong focus on viewing objects from a distance. Touching, breathing on, etc. is rarely welcomed. Of course, this is related to the fact that this leads to actual material changes, such as photographing with a flash. For the most part, works of art should rather be excluded from material changes (i.e. remain *closed* to a certain extent).
26 Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning,* 165.
27 Ibid. 72.
28 Rebentisch, *Theorien der Gegenwartskunst. Zur Einführung,* 135-37.
29 Ibid. 141.

the anthropocentric hierarchy so that I see myself as a human animal (or a pet).[30] Nonetheless, even if I *think* this many times, it may have less of an effect on my view of myself and the world than if I were to have just one aesthetic experience.

With his idea of conceptual art, Kosuth underestimated both the agency of the material (typeface, irregularities in the lettering, the structure of the paper and the irregularities it contains, the medium of his work, artifacts resulting from the enlargement, the way it is hung, etc.) and that of the subject in relation to the material. In contrast to Kosuth, Bohr holds that theoretical concepts cannot be pure abstractions but rather emerge from material configurations. Thus, as Bohr stated when determining the position and (or) momentum of a particle in quantum physics, it only makes sense to speak of the concept »position« of an object in relation to an apparatus within which this specific position can be established as a relation.[31] Nevertheless, it is precisely these alphanumeric abstractions of attributions that make them appear as real inherent properties in everyday life. We are not as big as this specific floor lamp, but have the size of an abstract number in conjunction with an abstract unit. There are pragmatic reasons for this: our world – which is largely organized by formal systems ("boundary-making practices") – would not function at all otherwise, although this does not mean that it has to be the way it is today.

Diffraction apparatus: Matter and meaning

> *[D]iffraction apparatuses measure the effects of difference, even more profoundly they highlight, exhibit, and make evident the entangled structure of the changing and contingent ontology of the world, including the ontology of knowing. In fact, diffraction not only brings the reality of entanglements to light, it is itself an entangled phenomenon.*[32]

In physics, diffraction refers to the superposition/interference of waves, i.e. their superposition or extinction. One of the examples presented by Barad describes (water) waves that move straight towards a wall in which there are two passages. As a result, the waves divide and create new – different – waves of superposition and extinction behind the wall. Referring to

30 This is more of a pun in German language: "Menschliches Tier (oder Haustier)," meaning human animal or animal living in a house.
31 Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning,* 139.
32 Ibid. 73.

Donna Haraway,[33] Barad presents »diffraction« as a methodological contrast to reflection: "both are optical phenomena, but whereas the metaphor of reflection reflects the themes of mirroring and sameness, diffraction is marked by patterns of difference."[34] According to Barad, reflection goes back to representationalism, i.e. the idea that representations reflect reality and that this practice has no influence on the things themselves.[35] While reflection (as a physical phenomenon) reproduces an object more or less accurately and does not change it, diffraction leads to a change in the object or phenomenon.[36] Similarly, the discursive method of diffraction focuses on differences in the form of particularities instead of similarities: "diffractions are attuned to differences – differences that our knowledge-making practices make and the effects they have on the world."[37] Diffraction apparatuses are "analytical instruments" that have to be "tuned" to the details of the phenomenon under investigation, but they also change it by generating "patterns of diffraction." Since they arise within the phenomenon itself and do not exist outside and detached from it, they are sometimes an instrument and sometimes an object of investigation. Nevertheless, they can gradually help us to investigate phenomena and generate knowledge about them.[38]

In the following, the thesis is put forward that works of art aim to be diffraction apparatuses. Even if the term »reflection« is often used in the context of the production and reception of art, the term »diffraction« much more clearly captures the essence. According to Ursula Brandstätter: "Aesthetic experience is often characterized as an experience of difference [...]. An essential function of art is therefore to break up traditional ways of perceiving and thinking. The ordinary is called into question, the familiar is made strange, irritations are intended to lead to a restructuring of perception and thought."[39] In art, we are confronted with sensually perceptible phenomena that run counter to our everyday experience and perception and thus bring them to our attention. The point of contemporary art is "to insert

33 Donna Haraway: "The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others." In Cultural Studies, ed. Lawrence Grossberg, Cary Nelson, and Paula Treichler, 295–337. New York: Routledge., 1992.
34 Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*, 71.
35 Ibid. 86.
36 Ibid. 81.
37 Ibid. 72.
38 Ibid. 73.
39 Ursula Brandstätter, "Ästhetische Erfahrung," Kulturelle Bildung Online, 2013, https://www.kubi-online.de/artikel/aesthetische-erfahrung

certain discontinuities into the continuum of chronological time. To be at the cutting edge of time, to be con-temporal, means, as Giorgio Agamben puts it, to divide time, to insert caesuras that make it legible in the first place."[40] Brandstätter states: "When we engage with aesthetic phenomena, we learn to deal with plurality, heterogeneity, differences and contradictions."[41] Since aesthetic experience leads to the "intertwining of self-reference and world-reference,"[42] not only is there an experience of difference from the world, but also from the experiencing and self-constituting subject itself. Christoph Menke formulates this following his criticism of Neo Rauch's painting *Amt*, which leads to the judgment that it is not an aesthetic object:

> *It is not an aesthetic object at all, because to be »aesthetic« means not to be an object, not to be an object for a recognizing and judging subject; but to be the opposite, indeed the opposite of the subject, capable of provoking the subject's reluctance to judge; an opposite, in other words, that eludes its constitution as an object just as much as it undermines the subject's self-constitution in the aesthetic play. Rauch's picture is bad because it does not have the power to make the judging subject unbearable to itself. What is aesthetically bad is the mere object – that in which the subject, in negative or positive judgment, can reflect itself. […] The aesthetically bad is the object of the judgment of good or bad, which, as a mere object, does not have the power to make the subject react against itself. The aesthetically bad leaves the subject in agreement with itself.*[43]

The relationship between object and subject is crucial. If an aesthetic object merely enables the reflection of one's own subjectivity, it is not an aesthetic object at all. On the other hand, an aesthetic object eludes subjective access and at the same time calls into question the constitution of the subject that it evokes. In aesthetic experience, one thing does not follow on from another in a strictly causal manner, whereby the subject would experience itself in its capability,[44] and there are leaps and changes of direction. There is no progress in the sense of logical reasoning that leads us to the one correct meaning. On the contrary, we can assign different – even contradictory – meanings to the object (without these being nested in the object itself). Within art, we realize that we do not arrive at a final interpretation (if it is good art), but that we could endlessly continue to play with the production of meanings in intra-action with the object.

40 Rebentisch, *Theorien der Gegenwartskunst. Zur Einführung,* 13.
41 Brandstätter, "Ästhetische Erfahrung."
42 Ibid.
43 Menke, *Die Kraft der Kunst,* 78.
44 "To have capability means to be a subject; to be a subject means to be able to do something. […] Every capability is the capability of repeating a general." In this, capability is social practice. If art is about the repetition of the general, art is social (trained) practice. Menke, *Die Kraft der Kunst,* 13.

Aesthetic apparatus [negative ontology]

> *Unlike the object of utility, however flexible it may be, the modern work of art is, in Adorno's formulation, determined through and through by its »enigmatic character«; it is determined by the fact that it eludes any clear definition and thus also any purpose. Works of art are things, writes Adorno, »of which we do not know what they are«.*[45]

In the opening quotation of the previous section, Barad speaks of the "ontology of the world, including the ontology of knowing" that becomes visible and negotiable through diffraction apparatuses. Not included is the ontology of non-knowing. In the previous section, (open) works of art were presented as diffraction apparatuses.[46] In the following, the thesis is further sharpened: works of art are not only diffraction apparatuses, but a special form that comprises the production of phenomena of non-knowing, things of which we do not know what they are. This special form – which agential realism lacks – is called aesthetic apparatus in the context of this text.

On a positive note, *the unknown* drives research and development. However, the aim is to resolve the unknown and the unknowable or circumvent them through the construction and maintenance of apparatuses. These not only define what is accepted as meaningful, but also what must be excluded.[47] *"[A]pparatuses are boundary-making practices."*[48] In view of the discursive constraints under which our knowledge is produced, we could understand these boundary-making practices as a form of dealing with the unknown, through exclusion. "Discourse is not what is said; it is that which constrains and enables what can be said. Discursive practices define what counts as meaningful statements."[49] According to Barad, thinking of discourse as something merely language-based follows the assumptions of representationalism. On the other hand, it is a material practice. Through the material configuration of reality, meaning is created and reinforced, as well as weakened, excluded and prevented. Discursive practices and knowledge production are not reserved for humans alone.[50] Nevertheless, Barad is primarily concerned with a modified scientific production of knowledge that

45 Rebentisch, *Theorien der Gegenwartskunst. Zur Einführung,* 34.
46 Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning,* 73
47 Barad in recourse to Foucault. Barad, 63.
48 Ibid. 148.
49 Ibid. 146.
50 Ibid. 375, 379.

does justice to physical-material reality. In contrast to art, she is not concerned with the *production of the unknown*.

Agential realism represents a counter-position to common ontology and epistemology. These are presented by Barad as too reductive (originally in relation to the interpretation of quantum physics, but then also explicitly in relation to attributions such as race and gender) and too anthropocentric (e.g. in the hierarchical distinction between culture/nature, human/non-human). In view of the growing global problems in the present world, it is also plausible to see these problems as a consequence of our inaccurate ontological-epistemological view of the world, which therefore requires a reorientation. Here, aesthetic experiences can serve as a practice field.[51] This is due to their concrete realization in sensually perceptible phenomena and their creation of diffraction apparatuses. Rüdiger Bubner describes the structure of aesthetic experience with Kant's reflective judgment, which is contrasted with the determining judgment. In the logical process of reasoning, the determining judgment takes action and attempts to subsume a particular under a general. This is contrasted with the reflective power of judgment, which finds a particular that cannot be subsumed under a general concept.[52] In aesthetic experience, it becomes clear that language as a form of representation is not identical with things and that these and their meanings cannot be fully grasped linguistically (being incommensurable). The back and forth between aesthetic watching and conceptual grasping, between "the structure of incomprehensibility" and the "expectation of understanding"[53] is already an open-ended diffractive process. "Judgment becomes confused and thus judgment becomes aware of its own function. It moves back and forth between an indeterminable particular and an unavailable general, and in this floating, the mediating movement is aesthetically

51 Here, it is important not to equate aesthetic experience with art. Problems *outside* of art can also be found *within* art; for example, in the form of exaggerated artist subjects that run counter to the ontology of aesthetic experience and agential realism. The »outside« in the above sentence does not withstand the ontology of agential realism. Nevertheless, this linguistic construct is used here in its conventionality with reference to this conventionality. In general, it is a difficult undertaking to formulate linguistically correct in the sense of agential realism, as our language and the associated conventions have adapted interactively with the dominant ontology, at least in the so-called West. This is comparable to the difficulty of putting the teachings of Zen Buddhism into words: "When I give a lecture, the audience and I find ourselves in a slightly paradoxical situation. With words and sentences that often become abstractions, I try to explain something that cannot be explained, while the audience tries to hear something that cannot be heard." Jakusho Kwong, Kein Anfang kein Ende. Die Essenz des Zen (München: Goldmann Verlag, 2004), 177.

52 Bubner, "Über einige Bedingungen gegenwärtiger Ästhetik," 36.

53 Ibid. 41.

activated."[54] It becomes palpable that attributions of meanings are not conclusive, but take place in an open process that is terminated at some point without coming to an end.[55]

Agential realism is committed to posthumanism but remains surprisingly anthropocentric. Ultimately – including in all of Barad's examples – the focus is on gaining knowledge from a human (scientific) perspective. Her epistemology is closely linked to the (controlling) subject, which exercises power through agency. Of course, it becomes very clear how distributed this agency is and how it emerges in temporary configurations, as well as the notion that agency can be lost, whereby a subject can become an object (see the phenomenon of ultrasound examination). Nevertheless – and particularly strikingly regarding her critique of representationalism – agential realism is strongly on the side of conceptual knowledge production through subjective capability. On the other hand, aesthetic objects block subjective control in aesthetic experiences and allow us to experience the limitations of our knowledge and understanding. In this respect, works of art – "calculated alienation"[56] – are diffraction apparatuses par excellence. Consequently, agential realism must be supplemented by the discursive practice of *producing the unknown,* that which we do not (cannot) know what it is.

54 Ibid. 36.

55 For many artists, the production of the artifact is also an open-ended process that must be artificially interrupted (by agencies). See Neo Rauch's statement about the final state of his paintings: "It is not finished. And it will never be finished. I'll stop working on it at some point, it'll be taken out of my hands, and then it'll be over. [...] So it just has to remain the way it is when the haulage men come to take it away." Neo Rauch. A German Painter, Documentary, 2008, sec. 38:30-39:30.

56 Bubner, "Über einige Bedingungen gegenwärtiger Ästhetik," 45.

Imprisoning people for weeks to prevent them from participating in protests is incompatible with human rights and the rule of law.
Amnesty International[1]

Christian Heck

The Duty to Prevent

Prologue

In order to prevent further disruptive actions during the International Motor Show (IAA, Munich) in September 2021, nine activists from the Aktion Autofrei were taken into preventative custody (aka preventative detention) until the end of the trade fair.[2] The legal basis for this was provided by the tightening of the Bavarian Police Duties Act (Polizeiaufgabengesetz, PAG) in July 2021. While the expansion of the police laws in the federal states was originally initiated to prevent terrorist and extremist acts, this form of imprisonment is now permitted in the event of *"immediately impending committal/continuation of a criminal offense/infraction that is of considerable importance to the general public,"*[3] as it is phrased in the Bavarian Police Duties Act. In 2023, activists were also taken into preventative detention in connection with the IAA before they could even do anything. According to spokespersons from the *Last Generation*, sixteen of those affected were detained until September 10, and an additional eleven were detained by order of the Munich District Court until September 30. This is the case because many non-governmental organizations (NGOs) were

1 Amnesty International, "Deutschland: Präventivgewahrsam für Klimaschützer*innen ist klarer Verstoß gegen die Menschenrechte," *Amnesty.de,* September 4, 2021, https://www.amnesty.de/allgemein/pressemitteilung/deutschland-klimaschuetzerinnen-praeventivgewahrsam-verstoss-menschenrechte (accessed 1/8/2024).
2 See Michael Trammer, "Polizei stört Protest gegen IAA," taz, 9 September 2021, https://taz.de/Stoerer-bei-Automesse-in-Muenchen/!5795867/ (accessed 1/8/2024).
3 "Gewahrsam nach Maßgabe des Gesetzes über die Aufgaben und Befugnisse der Bayerischen Polizei (PAG) (Munich, 2022)," https://www.gesetze-bayern.de/Content/Document/Y-300-Z-BECKRS-B-2022-N-41850? (accessed 1/8/2024).

planning demonstrations, blockades, and other protests against the IAA 2023, as they do every year. The Bavarian Interior Minister Joachim Herrmann (CSU) anticipated protests, especially *"from the anti-capitalist and climate change camps."* He went on to say, *"We will not tolerate any criminal acts! Anyone who stops others in traffic, damages the property of others, becomes violent towards other people, or hinders emergency services must expect the police to take firm action."*[4] However, no such offenses were committed by those arrested prior to their detention. On the contrary, the offenses were anticipated by the politicians and law enforcement authorities. Nevertheless, around 1,500 climate activists gathered for the protest in the end, and they were confronted by 4,500 police officers.

This occurrence that took place at the IAA 2023 in Munich is part of a trend towards *preemptive security policy,* just like the clearing of the Hambach forest or the flyover of the G8 protest camp in Heiligendamm, both of which were later declared unlawful.[5] There are numerous other cases – such as the preemptive arrest near Biarritz of three Franconian youths during the G7 summit in the summer of 2019 – that attest to this emerging trend. These three youths, who were actually on their way to the Basque country, were listed in a Bavarian *State Criminal Police Office (Landeskriminalamt,* LKA) database along with 121 others in Germany's left-wing scene. German authorities passed them on to the French security authorities. The travelers had no criminal record and none of them had ever committed a criminal offense or possessed illegal items. When questioned about the specific details, the Bavarian State Criminal Police Office and the German government did not disclose any information, citing *"reasons of state interest."*[6]

4 See Editor, "Munich vor der IAA: Immer mehr Klimaaktivisten in bayerischer Präventivhaft," Der Globus Deutschland, September 2, 2023, https://www.globusdeutschland.de/2023/09/02/munchen-vor-der-iaa-immer-mehr-klimaaktivisten-in-bayerischer-praventivhaft/ (accessed 1/8/2024).

5 See Bernd Müllender, "Ein Schlag in die Magengrube," taz, September 8, 2021, https://taz.de/Urteil-zu-Raeumungen-im-Hambi/!5799019/ and Pascal Beucker, "Angsteinflößend und einschüchternd," taz, October 26, 2017, https://taz.de/Kampffliegereinsatz-in-Heiligendamm/!5455805/ (both accessed 1/8/2024).

6 See. Konrad Litschko, "Zehn Jochen Präventivhaft," taz, 15 November 2019, https://taz.de/Festgenommene-Deutsche-bei-G7/!5638399/ (accessed 1/8/2024).

Security Policy in the 21st Century

> *Many people have asked how close Saddam Hussein is to developing a nuclear weapon. Well, we don't know exactly, and that's the problem [...] Facing clear evidence of peril (the attacks of September 11), we cannot wait for the final proof – the smoking gun – that could come in the form of a mushroom cloud [...] Understanding the threats of our time, knowing the designs and deceptions of the Iraqi regime, we have every reason to assume the worst, and we have an urgent duty to prevent the worst from occurring.*[7]

The term prevention has gained prominence in Western industrialized nations. Simultaneously, its social implication has undergone a significant change, reaching a point where its application has started to have an impact on our daily lives and on our society, not only in the interests of private companies, scientific research, national and international security, federal and state investigation offices, the police, the military, the Office for the Protection of the Constitution, and the secret services, but also in the interest of the people. Preventative measures are increasingly encroaching upon our social interactions, disrupting the spaces where we gather and engage in conversation. These are the places where our sense of solidarity is nurtured and the social significance of concepts are derived, i.e. they are places where *sense-making* takes place.

In this millennium, Western societies are redefining concepts such as *catastrophe, danger, crisis, and risk,* and even the concept of *terrorism,* while integrating them into novel and at times *disruptive technologies.*[8] It is becoming increasingly important for society to respond to these new, critical developments as a whole. To this end, we need to mitigate risks and ideally prevent predicted crises, attacks, uprisings, and disasters before they unfold. Such shifts in the meaning of concepts align with a reconsideration of the acceptability of preventative and preemptive measures to minimize risk.[9] This occurs regarding new global crises, wars, military conflicts, and the threats posed by terrorism and weapons of mass destruction, to gain sovereignty in matters of interpretation.

7 "Transcript: George Bush's speech on Iraq," The Guardian, 7 October 2002, https://www.theguardian.com/world/2002/oct/07/usa.iraq (accessed 1/8/2024).

8 Disruptive technologies are technological developments that offer the market a different and entirely new value propostion. Startups, big tech or new tech, the elites of artificial intelligence research, deliberately produce immature (software) products in comparison to sustaining technologies. The social significance of these can only become manifest when they are used. See, for instance, Clayton M. Christensen, The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail. (Boston, MA: Harvard Business School Press, 1997).

9 The term preemptive, or preemption, will be examined in further detail in the course of this article and distinguished from that of preventative (prevention). There is a risk that the respective measure within the technical system is considered final especially while attempting to implement preventative measures into technical systems. It is potentially presented as a variable in the functions of the system and can therefore be questioned increasingly less, the more automated the implementation processes take place.

Concurrent global events are fostering a new comprehension of interrelated crises, giving rise to complex *polycrises*.[10] Examples for this include the *dot-com* crash at the beginning of the millennium, the financial crisis in 2008, the Euro crisis in 2010, as well as 2015's refugee and migration crisis. Then came COVID-19, the crisis of democracy, the climate crisis, the Russian invasion of Ukraine, as well as other wars in Afghanistan, Iraq, Yemen, Libya, Mali, Syria, Israel and Gaza. Numerous environmental disasters have also occurred in this millennium, particularly in countries affected by war or in the process of rebuilding their devastated lives: earthquakes in Syria, Turkey, Morocco, Afghanistan, and Haiti have accounted for over 500,000 casualties, and floods in Pakistan, Libya, and Sumatra have claimed hundreds of thousands of lives due to a tsunami. Wildfires are breaking out all over the world. More than 43 million children are currently refugees in flight. Societies across the globe are called upon to address a wide range of concurrent challenges.
In order to avoid succumbing to a sense of powerlessness fueled by feelings of fear, uncertainty, anger, or helplessness, the traditional functions of technology have been reexamined and redesigned, in particular those that counteract spontaneous changes with stability. This means making the unexpected more predictable, risk factors more interpretable, and potential hazards more manageable. In addition to early crisis detection, crisis and conflict prevention also form a crucial foundation for minimizing risk. After all, no one denies that hundreds of thousands of lives can be saved every year by recognizing and preventing crises and conflicts in a timely manner. Much hope is attached to the analysis of new *big data* sources by artificial intelligence (AI) to enhance the predictive capacities of governments, institutions, universities and NGOs. In addition to *open-source intelligence* (OSINT), which can access media reports, academic papers, and publicly available statistics, early warning systems for crises must include reports from secret services, military intelligence, analyses from security agencies, findings from satellite reconnaissance, and a variety of other informational sources and encode them for computational processing.

10 See the definition of RiskNET, where "polycrises" are called "crises" that "reinforce one another." https://www.risknet.de/wissen/glossar-eintrag/polykrisen/ (accessed 1/8/2024).

After events from 2015, such as the arrival of a large number of refugees in a relatively unprepared Europe, political decision-makers sought ways to better anticipate flows of migration. Switzerland and Sweden have since started testing the prediction of asylum applications, and the European Union Agency for Asylum (EASO) has tested suitable prediction models as part of its *Early Warning and Preparedness System* (EPS). The Prediction, Visualization, Early Warning (PREVIEW) project at Germany's Federal Foreign Office also conducts early monitoring of crises. This is the case because – as the German Foreign Office postulates – *"Crises have their precursors. Problematic political, economic, and structural developments are often apparent before they erupt."*[11] In the Bundeswehr (German armed forces), programs like the IT support for the early detection of crises, which was developed by the German Federal Ministry of Defense. According to the ministry, the system has been an integral part of the German government's foreign, security, and development policy since 2017 and it was designed to *"determine the likelihood of crisis-related developments in militarily relevant contexts worldwide approximately one and a half to two years in advance."*[12] This early warning and assistance system links *"trade data, unemployment rates, crime rates, and also, for example, information about political violence from global event databases, such as the Global Terrorism Database (GTD), the Armed Conflict Location & Event Data Project (ACLED), and also the GDELT."*[13] Another project in this field – the Center for Crisis Early Warning (CCEW) – is currently being developed by the German Federal Ministry of Defense in cooperation the University of the German Federal Armed Forces in Munich. According to the Center for Intelligence and Security Studies (CISS), it conducts interdisciplinary research in advanced analytics and AI. Here, again the information is sourced from public or freely accessible sources, which the German Federal Ministry of Defense supplements with additional data sets.[14] Among other initiatives, IT-based early crisis detection

11 Auswärtiges Amt, "Krisenfrüherkennung, Konfliktanalyse und Strategische Vorausschau," https://www.auswaertiges-amt.de/de/aussenpolitik/krisenpraevention/-/2238138 (accessed 1/8/2024).
12 Bundesministerium der Verteidigung, "Auswärtiges Amt und BMVgBundesministerium der Verteidigung stärken gemeinsame Krisenfrüherkennung," https://www.bmvg.de/de/aktuelles/bmvg-auswaertiges-amt-staerken-gemeinsame-krisenfrueherkennung-4960694 (accessed 1/8/2024).
13 Ulf von Krause, "Potenziale der KI im Militär," in Künstliche Intelligenz im Militär: Chancen und Risiken für die Sicherheitspolitik (Wiesbaden: Springer Fachmedien Wiesbaden, 2021), 9–23.
14 Center for Intelligence and Security Studies (CISS), "Kompetenzzentrum Krisenfrüherkennung," https://www.unibw.de/ciss-en/ccew (accessed 1/8/2024).

with quantitative methods for national, foreign, and security policy is being further developed in collaboration with the German Federal Foreign Office. In May 2020, the *Data Innovation Directory* (DID) was also launched as part of the *Global Migration Data Portal of the International Organization for Migration* (IOM), which presented more than 50 projects that used AI, big data, mobile phone data, and satellite images to better understand the impact crises have on mobility. However, data sets concerning the market prices of goats in Somalia – for instance – also serve as a basis for AI early warning systems to predict refugee movements from the country of origin, such as within the UNHCR project *Jetson*.[15] Literary texts are also being analyzed as predictive instruments for the prevention of crisis and conflict. For three years, the project *Cassandra – Literature as an Early Warning System*[16] was commissioned by the German Federal Ministry of Defense to research the predictive potential of literature in crisis-prone regions: In Ukraine, Nigeria, Algeria, the Kuwait/Bidun- and the Nagorno Karabakh conflict.

It is especially essential for executives in public offices and companies who need to accurately validate the predictions from these at times still very experimental systems to acquire a basic understanding of the internal structures of these technical systems. A misjudgment in using these systems during a normal day of work could have concrete, sometimes devastating or fatal consequences for citizens. However, a growing challenge is that it will be increasingly difficult to assess the quality of each technical model as computer-assisted predictions become more automated. A prediction can only be as good as its model.

A Technically Generated Reality

> *That which has been coded, transmitted to thousand of machines, and has become part of our day-to-day lives because it has been repeated again and again will stabilize and ultimately become a culturally unquestioned sediment.*[17]

Software developers determine the fundamental behavior of the system via its internal structure and interfaces with the world. The system

15 Lauren Parater, "Jetson: Insights into Building a Predictive Analytics Platform for Displacement," UNHCR Innovation (blog), March 21, 2018, https://www.unhcr.org/innovation/jetson-insights-into-building-a-predictive-analytics-platform-for-displacement/ (accessed 1/8/2024).

16 See Markus Metz and Georg Seeßlen, "Kann Literatur Krisen prophezeien? - Cassandra," https://www.hoerspielundfeature.de/feature-cassandra-100.html (accessed 1/8/2024).

17 Georg Trogemann, "Code and Machine" in Code: Between Operation and Narration, Eds. Andrea Gleiniger and Georg Vrachliotis (Basel: Birkhäuser, 2010). 41–53.

only exerts its impact through the selection of the context in which it is employed, which also includes the involved users and their interactions with it. In other words, the external conditions of the system need to be maintained to ensure its continued functionality in the future. Modeling parts of the world and the predictions composed from such parts *"for linear systems that are well demarcated and that only interact loosely with their environment […] actually work out very well,"* but they fail in *"all areas for which interactions with the environment cannot be limited."*[18] Hence, the current settings need to be (re)configured to allow for the envisioned efficacy of the technical functions to be manifest in a particular context. This applies to all components involved in realizing the fictional model and the group of people who are included as datafied objects or operands; otherwise, their intended mode of operation would no longer be guaranteed. However, if it can be guaranteed, users of a particular technical system can rely on the deployment of the software's specified functions. Surprises are then only likely to be rare cases. The functions have a stabilizing effect. They counteract spontaneous changes or prevent them from ever being able to happen in the first place. They minimize the unexpected and preemptively prevent possible risks. The internal functions achieve this by predicting the future state of the environment to some extent. This means that in order for the systems to fulfill their functions, the internal operations have to lead from a specific initial situation to a target state as flawlessly as possible.

In the past 25 years, some predictive systems have worked better than others. However, criteria concerning *why* and *for whom* they have worked better or worse need to be defined from within society. They should be in the interest of the public and thus they should not be evaluated exclusively by communities of software developers but rather in conjunction with them. After all, humans have been deliberately intervening in their environment since time immemorial,where environment is understood as the environment of a living being that affects it and influences its living conditions.[19] Humans configure and manipulate their environment to create future habitats (for survival) and avoid exceptional circumstances as much

18 Georg Trogemann, "Reenacting Poiesis – More Anarchy in Technology!," in Reenactments in Kunst, Gestaltung, Wissenschaft und Technologie, Salon Digital Band / Vol. 1, Edited by: Ralf Baecker, Dennis Paul, Andrea Sick (Hamburg: Textem Verlag, 2020). 133–155.

19 See Jakob Johann von Uexküll, Umwelt und Innenwelt der Tiere (Berlin: Springer Verlag, 1909).

as possible. This way of stabilizing and reducing uncertainties has always been a fundamental quality of technical manufacturing processes; it is part of our world. A world that mankind created for itself and in which human life is at home: *"an artificial world of things, distinctly different from all natural surroundings."*[20] This in turn gave rise to new techniques and technologies. Some were developed intentionally, while others appeared as side effects, thus posing unforeseen challenges. They did this and still do via our technical interventions in the world. Whenever they become integrated into our behavior and significantly influence our lives and work, the initially liberated sense undergoes a reversal. A reversal that reimbues what had been previously removed through the process of abstraction, namely all of the ambiguities and inconsistencies of life itself. To make life readable for machines, phenomena must be detached from concrete reality, they have to be liberated from meaning. All that is abstracted away is then reimbued during the interaction between human and machine, where the abstract resurfaces through interfaces, in the intersections with the world. The abstract symbols are imbued with meaning, but these meanings are not identical to those previously removed. This reimbuing represents a fundamental aspect of *sense-making* when cultural values that were once inscribed in technologies start triggering new value debates in society.[21] Thus, whenever computer systems are used in real-world settings – i.e. whenever they are embedded in an environment – they activate new contexts of action. It is then up to society to extrapolate them, which is one of the reasons why political regulation often lags behind technological development.

The technologies discussed in this article are primarily used for *anticipatory intelligence*, i.e. to support military decision-making and in the realm of national security. They are integrated into existing contexts of action and recontextualize them when they appear via recharging during the computer-assisted acquisition of knowledge. The purpose of these systems is always to handle future crisis situations. With and through them, new spaces for experience and action are constantly emerging that did not exist before. In the first two decades of the new millennium, we thereby learned

20 Hannah Arendt, Human Condition (Chicago: University of Chicago Press, 1958), 7.
21 See Georg Trogemann, "The Wealth of the Concrete on the Skeleton of the Formal," 2014, https://georgtrogemann.de/wp-content/uploads/2021/04/Wealth_of_the_concrete_English.pdf (accessed 1/8/2024).

to acknowledge that technology increasingly outpaces our understanding of the world. *"that what we can cognize changes to the same extent as the technical modifications we make to our world."*[22] And with this realization, the technological predictions of our future life also change.

Prevention < Prediction > Preemption

In their study, "Prediction, Preemption, Presumption: How Big Data Threatens Big Picture Privacy," researchers Ian Kerr and Jessica Earle introduced the concept *"predictive preemption."*[23] For this concept, they distinguished three models of technical prediction to gain a deeper understanding of the computer-assisted transformation of our living environment. Kerr and Earle divided technical prediction into *consequential, preferential,* and *preemptive* prediction. Various types of scenarios can be predicted with all of these models in which social processes and movements are not only recorded, analyzed, and shaped in the present, but also in which futures can be simulated. Some of these simulations are then optimized in a preventative fashion and steered in a specific predefined direction. Depending on the degree to which the future is technically possible, attempts are even made to preemptively prevent them. As mentioned above, these models have become a constituent part of our daily lives:

1. *Consequential predictions* are predictions that attempt to anticipate the likely consequences of an individual's or group's actions. The algorithms used in this process belong to classical risk management systems and ideally they are user-centered by providing future courses of action that align closely with the interests of the individual in question. This choice is intended to prevent unfavorable outcomes for the individual, such as in medical treatment or legal advice.
2. Algorithms that can be attributed to *preferential prediction* not only attempt to make predictions about possible or probable consequences of individual or group behavior but also seek to influence the preferences of individuals and groups to promote better sales of specific products or services. Even

22 Georg Trogemann, "The 18th Camel and The Habitats of Thought. On the Paradox of Teaching Technology in the Arts," in Shared Habitats, Eds.Ursula Damm / Mindaugas Gapsevicius (Bielefeld: transcript Verlag, 2021). P. 117 – 166. 163.

23 Ian R. Kerr und Jessica Earle, "Prediction, Preemption, Presumption: How Big Data Threatens Big Picture Privacy," SSRN Scholarly Paper (Rochester, NY, September 3, 2013).

political opinion can be steered through their deployment. Google's *PageRank* algorithm and Facebook's *EdgeRank* algorithm fall into this category. Content moderation systems that implement such filtering and ranking algorithms play a crucial role in how information is located, accessed, and presented to us on the internet. Operating with specific parameters and values, they are constantly evolving through the intervention of humans and the technical systems themselves. Embedded in a complex combination of political, technical, cultural, and social interactions, these algorithms significantly influence worldviews. The boundaries between commercial risk management systems and those for preferential prediction, where choices can be intentionally directed, not only intersect with political agendas (like in the *Cambridge Analytica* scandal in 2018, for instance)[24] but also with models used in the military and national security. An opaque *"amalgam of commercial, private, military, and technological techniques"*[25] began to form that by the mid-2010s focused on solutions to identify unknown elements in (big) data mining. *"The commercial retailer's dream of an unknown consumer meets the state's nightmare of an unknown terrorist."*[26] Thus, preemptive security technologies, which emerged around the turn of the century, acquired an additional dimension by the 2010s.

3. While the first two models focus on the actions of an individual or group, preemptive systems assess probable consequences that could occur once a person or group is either permitted or forbidden to act in a certain way. The differentiation here is between legal and illegal actions, and between what is or will be allowed in the future and what is forbidden. *Preemptive predictions* therefore focus on predictions that are deliberately used to restrict the future range of actions for an individual or group and are only rarely used to expand such a scope. The suppositions of preemptive predictions are usually modeled from a state or company's

24 See Nicholas Confessore, "Cambridge Analytica and Facebook: The Scandal and the Fallout So Far," The New York Times, April 4, 2018, https://www.nytimes.com/2018/04/04/us/politics/cambridge-analytica-scandal-fallout.html (accessed 1/8/2024).

25 Louise Amoore, The politics of possibility: risk and security beyond probability (Durham: Duke University Press, 2013). 2.

26 Ibid. 3.

perspective, meaning an entity that seeks to prevent or avert certain actions or perspectives. As such, one single actor gains so much power within a system that other parties and actors no longer have a chance to be or become their equal, and by definition, this is a system that is inherently unequal. This concept can be referred to as *hegemonic data processing*.[27] Big data combined with AI pattern recognition – for example – is one such technical system of hegemony, or rather, there are many such systems. They are hegemonic because a few (national and international authorities, IT companies, security services, etc.) entities collect data from citizens using machine learning algorithms, store such data in a black box, and recycle it *"with the aim of predicting events, states, or developments in the future."*[28] This usually occurs without citizens being aware of it. The increased use of big data in medium to large IT companies and the demands of security authorities to make predictions via *deep learning*[29] – i.e. creating automated databases through the design of data-driven algorithms – is further exacerbating this imbalance.

The efficacy of these systems becomes apparent in our everyday lives when – for example – a *social media* account classified as suspicious is suspended without any prior notice or explanation. Or when access to specific public or private infrastructures is denied to an individual based on a computed suspicion, whether to flights based on *no-fly* lists (see below), opening accounts based on a low-rated *Schufa score*,[30] access to public spaces online or out on the street due to a computed *endangerment index* (see below).

27 Following Gramsci, the concept of hegemony refers to a type of rule that is essentially based on the ability to define and assert one's own interests as the general social interests. See Antonio Gramsci, Gefängnishefte, Eds. Klaus Bochmann and Wolfgang Fritz Haug (Hamburg: Argument, 1991-2002).

28 Eric Mülling, "Workshop: Big Data und der digitale Ungehorsam," presentation slides, October 15, 2016, https://docplayer.org/177473931-Workshop-big-data-und-der-digitale-ungehorsam.html (accessed 8. 1.2024).

29 The technology of Deep Learning began to emerge at the turn of the millennium. The age of big data (ie the increase of data volumes due to the spread of internet technologies) began shortly after major processes had been made in computer technologies (i.e. in computing capacity, GPUs, and inexpensive storage capabilities). It was this technical infrastructure that allowed for the further development of artificial neural networks (ANN) to be possible for deep learning in research and increasingly also in the field of application. This is the technology we primarily talk about today when we hear about artificial intelligence: sub-symbolic artificial intelligence.

30 SCHUFA Holding AG is a company where information about consumers is sourced from utility suppliers, banks, internet providers, and more. The company tracks all bills or fines over time. Using this raw data and parsing it through an algorithm of their own, SCHUFA calculates the potential risk of default and translates this into a credit rating score for all German residents. The higher the score, the better the solvency. Scoring means in that sense, drawing up forecasts for the future based on experience from the past.

The Principles of Preemptive Security Policy

> *The message is that there are no knowns. There are things that we know that we know. There are known unknowns. That is to say there are things we now know we don't know. But there are also unknown unknowns – things we don't know we don't know.*[31]

If one follows this quote from former US Secretary of Defense Donald Rumsfeld, the world was faced with the need to transition into a preemptive security due to the security situation's unpredictable complexity. What had been coursing through Western societies in the previous century[32] now began to be inscribed into the countries' laws and into the existing security technologies. Numerous state-initiated measures aimed to assert sovereignty of interpretation over a security concept grounded in a logic of precaution and normalize the societal distrust of the Other.[33]

Reconfiguration of the Law:

The legal basis that enabled the Bavarian State Criminal Police Office to maintain the database from the prologue and disclose the names of the three youths has not been made public, due to *"reasons of state interest."* The case transpired in the summer of 2019, but it was not until a few months later, on January 1, 2020, that an amended EUROPOL regulation[34] came into effect that significantly expanded the power and prospects for cooperation between European police forces. It made the transferal of data and information to non-EU countries permissible as well as *loosely defined entities within the EU*. Hence, the legal basis for the preemptive actions by the French security authorities would have been established by 2020 at the latest. In the context of the new European security policy, several laws have been expanded or fundamentally changed in recent years. *"Preemptive security requires a radical reconfiguration of the law,"*[35] which has often

31 NATO Speeches Transcript, "Press Conference by US Secretary of Defence, Donald Rumsfeld," NATO HQ, Brussels, June 6, 2002, https://www.nato.int/docu/speech/2002/s020606g.htm (accessed 1/8/2024).
32 See Giorgio Agamben, State of Exception (Chicago: University of Chicago Press, 2005).
33 See Aradau, Claudia and Rens van Munster. "Taming the future: The dispositif of risk in the war on terror," in Risk and the War on Terror (Routledge, 2008).
34 REGULATION (EU) 2016/794 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32016R0794 (accessed 1/8/2024).
35 See Richard V. Ericson, "The State of Preemption: managing terrorism through counter law," in Risk and the War on Terror (Routledge, 2008). 57.

been accompanied by *state-of-the-art* security technologies. According to Richard V. Ericson, this takes two forms: first, new laws are enacted or novel interpretations of existing laws are devised; and second, these are accompanied by the development of surveillance infrastructures and new possibilities to expand existing surveillance networks. Both are undertaken *"to erode or eliminate traditional principles, standards, and procedures of criminal law that get in the way of preempting imagined sources of harm."*[36] Arguably, the most important step in this direction in the UNITED STATES was the enactment of the *Patriot Act,* which repealed previously established principles, standards, and procedures of criminal law in the name of national security shortly after the events September 11, 2001. This act also introduced the concept of an *"unlawful enemy combatant"* From that moment on, this status could be assigned to individuals based on a categorical suspicion, namely being in the wrong place at the wrong time or moving or behaving incorrectly. *"'Unlawful enemy combatants' is a dangerous offender-like status that criminalizes suspects for imagined future harm they might cause, rather than past crime."*[37] U.S. law enforcement agencies now had extensive access to private spheres, locations, and communication networks. Everyone became a suspect and to a certain extent was treated as such. Every citizen posed a risk and was thus under general suspicion. The Patriot Act included *"a legalization of access to communication and database infrastructures that might yield signs of suspicious activity, for example those of telephone companies, Internet Service Providers (ISPs), libraries, retailers (e.g., book stores, travel agencies, car dealers) and schools (eg., under a 'foreign student monitoring program')."*[38]

Expansion of Surveillance Infrastructures:

In both the UNITED STATES and Europe, new surveillance infrastructures have been developed since the beginning of the millennium, accompanied by the expansion of existing surveillance networks to incorporate new modes of utilization. The second form of preemptive security logic, which Richard V. Ericson calls *surveillant*

36 Ibid.
37 Ibid. 62–3.
38 Ibid. 66.

assemblages,[39] has been investigated in several EU projects. A representative example of an assemblage of new perspectives to use existing surveillance infrastructures and new innovations in the sector is the project *Intelligent information system supporting observation, searching and detection for security of citizens in urban environments* (INDECT). Running from 2009 to 2014, this EU research project was part of the 7th Framework Program for Research in the field of *intelligent security systems*.

The main objective of the research project was to develop a central interface in which surveillance data from various sources could be linked and automatically analyzed by computer programs for potential *threats or abnormal behavior*. The intent was to support police authorities and other domestic agencies and intelligence services in monitoring and tracking suspects. INDECT also aimed to promote and intensify a cooperation with *FRONTEX,* the agency responsible for securing Europe's external borders. By networking and integrating numerous, often very divergent surveillance technologies, it was hoped that violence and abnormal behavior could be automatically detected and reported. *"In summary, the aim was/is to develop technologies to make police surveillance more effective than it was by connecting and linking existing systems and information sources."*[40]

Criminal Potential

The aforementioned and other extensive data feeds and acquisition of citizens' behavior in Europe were utilized to establish databases to implement predictive policing. *"The databases for predictive analytics are constantly being fed in real time. Everything from crime statistics to the current weather conditions are being captured."*[41] Probably the best-known database worldwide – at least in the context of preemptive security policy – is the *No-Fly List* and above all the *Terrorism Screening Database* (TSDB) in the United States, now known as the *Watchlist*. Managed by the Terrorist Screening Center (TSC), the database contains biographical and biometric data on 4,600 US

39 Ibid.

40 Sylvia Johnigk and Kai Nothdurft, "INDECT – ein weiterer Schritt zum Orwellschen Überwachungsstaat?," in FIfF-Kommunikation 1/2010 "Verantwortung 2.0," Eds. Forum of Computer Scientists for Peace and Social Responsibility (FIfF) e.V. (Bremen: 2010).

41 M. Rosenbach and H. Stark, Der NSA-Komplex: Edward Snowden und der Weg in die totale Überwachung (Penguin Random House Verlagsgruppe GmbH, 2014). 283.

citizens and over one million residents in countries outside the United States who have been suspected by law enforcement or border officials in the United States and other countries of having ties to terrorism.

Being included in this list can have serious consequences for individuals and can lead – for example – to the loss of employment or inability to travel. Authorities need no evidence of criminal activity to add individuals to the watchlist. The United States shares the *TSDB Watchlist* with more than 60 countries, including the UK and countries in the EU, which can use it to detain and question listed individuals or deny them travel. The Obama administration silently authorized a significant expansion of *the terrorist watchlist system* and initiated a secret process that requires neither *concrete facts* nor *irrefutable evidence* to designate US citizens or foreign nationals as terrorists. These new guidelines made it possible to designate individuals as representatives of terrorist organizations without there being any evidence showing that they are actually associated with such organizations. Furthermore, they grant individual White House officials the authority to add entire *categories* of people to the list targeted by the government.

In Germany, this trend manifested itself in the term *"Gefährder"* (in English, a person likely to threaten public safety). It is a term that has become constantly employed in the language of security authorities over the past 20 years: *"a potential Gefährder is a person for whom certain facts justify the assumption that they will commit politically motivated crimes of considerable significance, especially those pertaining to the meaning of § 100a of the German Code of Criminal Procedure."*[42] The focus of the security authorities in dealing with the growing threat of Islamist-motivated terrorism, including in Germany, shifted from concrete to abstract, anticipated offenses. It has shifted, in other words, from criminal acts to a suspicion of behavior that does not fall within the realm of criminality. This was facilitated – among other things – by the legal framework established through the enactment of new police duties acts in Germany's federal states, which significantly expanded the powers of police against potential *Gefährder*. With the use of this concept, the

42 Deutscher Bundestag Drucksache 18/7151, http://dip21.bundestag.de/dip21/btd/18/071/1807151.pdf (accessed 1/8/2024).

criminal potential[43] was to be predicted, especially in preventing Islamist-motivated terrorist attacks, but in recent years also of right-wing extremist-motivated acts of violence and killings. For this purpose, software was developed in 2015 together with psychologists from the University of Konstanz: Rule-based Analysis of *Potentially Destructive Perpetrators to Assess Acute Risk – Islamist Terrorism* (RADAR-iTE),[44] and in 2022, together with the Central Criminological Office (KrimZ), the software RADAR-rechts.[45] The predictions generated by RADAR-iTE rely on an eight-stage predictive model for risk assessment. At level 1, the occurrence of a threatening event is to expected and at level 8 this is something that can be ruled out.[46] After Anis Amri's Islamist-motivated attack on the Christmas market in Berlin on December 19, 2016 – in which a total of thirteen people lost their lives and 67 visitors were injured, some seriously – few could comprehend how someone who was already under intense surveillance by the Berlin police could be capable of such an attack. Eventually, it was disclosed that the authorities had made a series of misjudgments and Amri was not considered an acute threat. Shortly after the attack, RADAR-iTE made its first appearance in the media as a new *"method to better expose top-level threats."*[47] Numerous media outlets at the time concluded that RADAR-iTE may have been able to prevent what happened. Before the attack, the data available on Amri had been cross-checked with RADAR-iTE and, unlike the Berlin police force, the prediction model would have *"classified Amri in the highest category – Red (high risk)."*[48]

Unrealizable Fictions

To a certain degree, the development of systems like RADAR-iTE, *watchlists*, or automated event databases implies the implementation of fictions in technical systems. Fictions that are functions

43 Deutscher Bundestag Drucksache 18/11163, https://www.bundestag.de/resource/blob/498694/76f82280dcc2c6f16722b181cada3b34/18-4-806-G-data.pdf (accessed 1/8/2024.

44 See Bundeskriminalamt (BKA), "RADAR (Regelbasierte Analyse potentiell destruktiver Täter zur Einschätzung des akuten Risikos)," BKA, https://www.bka.de/DE/UnsereAufgaben/Deliktsbereiche/PMK/Radar/radar_node.html (accessed 1/8/2024).

45 See Bundeskriminalamt (BKA), "RADAR-rechts" BKA, https://www.bka.de/DE/UnsereAufgaben/Deliktsbereiche/PMK/PMKrechts/RADAR/radar_node.html (accessed 1/8/2024).

46 See also the RADAT-iTE infographics of the BKA: https://www.bka.de/SharedDocs/Downloads/DE/AktuelleInformationen/Infografiken/Sonstige/infografikRADARiTE.jpg? – blob=publicationFile&v=8 (accessed 1/8/2024).

47 Fabienne Rzitki, "Radar-iTE: BKA-Methode soll Top-Gefährder besser entlarven," December 18, 2017, web.de, https://web.de/magazine/politik/radar-ite-bka-methode-top-gefaehrder-entlarven-32706414 (accessed 1/8/2024).

48 Ibid.

attempting to derive future events, such as a planned attack, as concretely as possible from individually observed processes, traces, and external actions. Of course, this practical approach requires an extremely high degree of speculation as well as thought experiments, given that this type of prediction can never achieve absolute certainty. A suspicion can only become more concrete if new actions align with the current prediction model, or this model has to be weakened or discarded should new data be in contradiction with it. However, as crisis and conflict prevention measures are implemented to detect crimes, attacks, crises, and conflicts promptly to prevent exceptional circumstances such as violent escalations, their efficacy needs to be proved before an individual or group decides to take action. Accordingly, before a terrorist attack is carried out or observable preparations for such an attack are made. This is one of the main reasons why crisis and conflict prevention are referred to as *"preventative diplomacy,"* in the programmatic UN document "Agenda for Peace"[49] from 1992. There, technical early warning systems are placed alongside diplomatic visits, talks, negotiations, trust-building measures, and preventative interventions in the form of establishing demilitarized zones. This is all undertaken because we do not have direct access to people's thoughts and intentions. To identify intentions and concrete plan with technical systems, they must always be derived from observable actions or statements. This means that only certain traces left by concrete intentions can actually be captured.

However, Western modern societies are characterized by the ways in which every day life is technologized since *"reproducible written traces are left everywhere,"* which *"in turn are the preconditions for further operations."*[50] In the interdisciplinary scientific field of *computational social science* (CSS),[51] traces such as those that "PREVIEW" and INDECT attempt to record are called *digital behavioral data*.

These traces are rendered interpretable by emerging digital technologies such that they can be used to examine social phenomena and their related epistemological practices. CSS, in particular, builds on

49 United Nations (UN), "Agenda für den Frieden (Bericht des Generalsekretärs), Ziffer 23," https://www.un.org/depts/german/friesi/afried/a47277-s24111.pdf (accessed 1/8/2024).

50 Armin Nassehi, Muster: Theorie der digitalen Gesellschaft (Munich: C.H.Beck, 2019). 136.

51 The CSS is a young field in the sciences where socio-cultural phenomena are treated with the aid of new technologies, such as machine learning, text and data mining, and network analysis.

the insights of *social network analysis* (SNA), a method of empirical social research to acquire and analyze social relationships and networks, which has been in use since the 1930s.

Can a Model Predict a War?

When criminologists such as Richard V. Ericson, philosophers such as Giorgio Agamben, or legal scholars such as Alan M. Dershowitz highlight that the American response to the terrorist attacks of September 11, 2001 illustrated a trend towards preemptive security that was nevertheless already underway in all Western societies, one inevitably has to come to terms with the so-called *revolution in military affairs* from the late 1990s, which is known as *Network Centric Warfare* (NCW).

The preemptive security logics of today have evolved from numerous spin-in and spin-off effects, i.e. innovations from industries, businesses, and society that were adopted by the military and vice versa. This is how military technologies found their way into our civilian spaces, into public and private spheres where we move and communicate or simply chat with one another. The knowledge, technologies, and skills from the SNA began to manifest themselves in the NCW as military-strategic, security-political, and operational ways of thinking. Their abilities were first demonstrated by the United States military in the Second Gulf War (1990) and from there they started to be developed in the US domestic and foreign security policies. Approximately three years later, on June 26, 1993, the first preemptive strike led by the United States was recorded under the term *"preventative military strike."* The United States used cruise missiles to attack the intelligence center near Baghdad and this strike resulted in 60 civilian casualties. According to former President Clinton, the operation was a measure taken against Iraq's alleged plans to assassinate Clinton's predecessor, George Bush, during a visit to Kuwait.

The quickly implemented reactions to the terrorist attacks of September 11, 2001, which included a NATO offensive against the Taliban that was led by the United States on October 7, 2001, would not have been possible without the longer-term asymmetric and hybrid warfare from the years and decades before. Or at least not in this dynamic. The possibility of quickly opening numerous sales offices of

technology companies in Washington and their rapid staffing *"with retired military and security officials"*[52] had also been established years before. Among the major companies included were Microsoft, IBM, Dell Computers, and the Oracle Corporation.[53] During this time, the Pentagon issued numerous funding programs in the field of SNA, regarding new forms of terrorist attacks and assassinations. Data analysis companies such as Palantir Technologies Inc. played a significant role during this period. These were companies that quickly specialized in monitoring individuals and consolidating data sets that had previously been separate. The CIA, the NSA, and the FBI quickly became Palantir customers. EUROPOL now also uses Palantir products for data analysis. Its software products are also in strong demand by NATO members countries and they play an important role in current wars such as the Russia Ukraine war and the Israel Gaza war. In Germany, Palantir's *database visualization and analysis software* Gotham[54] is used in Bavaria, among other places, as a *cross-procedural research and analysis platform* (Vera[55]). The police in North Rhine-Westphalia also use Palantir's *cross-database analysis and research software* (DAR[56]). In Hessen, Gotham has been used in the HessenData[57] police software since 2017. The state government in Hessen had approved the purchase of the software, but its use was deemed unconstitutional by the Federal Constitutional Court in Karlsruhe in February 2023. The judges of the Higher Regional Court in Karlsruhe gave the state legislature until September 2023 to make improvements to the law with regards the use of big data software by the police in Hessen. However, according to the *Society for Civil Liberities* (GFF), the second attempt is also incompatible with the supreme court's requirements. The GFF will submit a constitutional complaint to the Federal Constitutional Court. Hessendata can presumably be used *"if a person buys glue"* and could therefore be suspected of climate activism, criticizes

52 Richard V. Ericson, "The State of Preemption: managing terrorism through counter law," in Risk and the War on Terror (Routledge, 2008). 69.
53 Ibid.
54 See Bundeskriminalamt, "RADAR-rechts" BKA, https://www.bka.de/DE/UnsereAufgaben/Deliktsbereiche/PMK/PMKrechts/RADAR/radar_node.html (accessed 1/8/2024).
55 See Bayrisches Landeskriminalamt, " Projekt VeRA: Ergebnis der Quellcodeüberprüfung" LKA Bayern, https://www.polizei.bayern.de/aktuelles/pressemitteilungen/045266/index.html (accessed 1/8/2024).
56 See report for the meeting of the Committee on Internal Affairs, "Wie begründet die Landesregierung die Kostenexplosion beim umstrittenen Palantir-Analysetool?" Ministerium des Inneren NRW, https://www.landtag.nrw.de/portal/WWW/dokumentenarchiv/Dokument/MMV18-301.pdf (accessed 1/8/2024).
57 See Giel Ritzen, "Hessendata and its Impact on Personal Data Protection and Privacy" Police-IT, https://police-it.net/hessendata-and-its-impact-on-personal-data-protection-and-privacy (accessed 1/8/2024).

Simone Ruf from the GFF.[58] According to available data, the system technically merges digital behavioral data with entries in various police databases as well as connection data from telephone surveillance to identify possible criminals. However, the US Department of Defense also initiated its own innovative research and development programs such as the *Human, Social, Cultural, and Behavior Modelling Program (HSCB),*[59] which was sponsored by the *Office of the Under Secretary of Defense for Research and Engineering (OSD R&E)*. Most of them emerged and focused their main research areas and development core on predicting (abstract) future attacks as concretely as possible. New units were set up, such as the *Joint Improvised-Threat Defeat Organization* (JIEDDO), among others. This unit was one of the first units to test Palantir's Gotham for the war on terror. The JIEDDO was installed due to the need to address a rising number of attacks involving parcel bombs and *improvised explosive devices* (IEDs) during the Third Gulf War. In Baghdad, an increasing number of civilians and soldiers lost their lives.

The focus of methodological and technological developments shifted from the early detection or prediction of future attacks or the recording of the development of crises to the preemptive prediction of unrest, uprisings and wars. Ideally, the methods should also be able to prevent what they have detected and predicted. Prominent examples of the application of preemptive security technologies that emerged from this research approach are the networkalysis tool *Organization Risk Analyzer* (ORA)[60] and the *Spatial Cultural Abductive Reasoning Engine* (SCARE).[61] The latter was developed by V.S. Subrahmanian, among others, who was then the director of *the Laboratory for Computational Cultural Dynamics at the University of Maryland*. According to Subrahmanian, SCARE could predict the locations of weapons caches to within half a mile in Baghdad by using a combination of publicly available data on previous suicide attacks, geographic constraints, and cultural factors: first, attackers

58 See Simone Ruf, Jürgen Bering and Constanze Kurz, "Der sehende Stein der Polizeibehörden: Der Einsatz von Palantir Gotham aus technischer und rechtlicher Sicht,", presentation at Chaos Communication Congress 37C3, December 29, 2023, https://media.ccc.de/v/37c3-11989-der_sehende_stein_der_polizeibehorden (accessed 8. 1.2024).

59 See, for example, the introduction of the Defense Technical Information Center (DTIC®) into the program of HSCB: "INTRODUCTION TO THE HSCB PROGRAM," 2009: https://apps.dtic.mil/sti/tr/pdf/ADA496310.pdf

60 Kathleen Carley and Jeff Reminga, "ORA: Organization Risk Analyzer," July 1, 2004. P. 50.

61 See Paulo Shakarian, V Subrahmanian, and Maria Sapino, "SCARE: A Case Study with Baghdad," 2009. And the corresponding presentation slides: https://pdfs.semanticscholar.org/8a08/96fcf863ec937d72ecf98ffefc60ac6f01fa.pdf (accessed 1/8/2024).

could not carry their explosives very far in part for the fear of being caught; and second, most of the tracked attacks were carried out by Shiite groups with links to Iran, which meant that it was unlikely that the hideouts were in Sunni neighborhoods. Subrahmanian later stated that he had provided copies of the program to the military and stated that *"they're clearly trying it out."*[62] However, the extent to which remained classified.

Programs such as SCARE enhanced the efficacy of security policies through computer-assisted interpretations of observable intentions among groups and individuals, which evolved in tandem to the extent to which they could make an (abstract) future event concrete. The United Nation's reading that early crisis detection should not suggest 100% guaranteed predictions about the future but instead explicitly refer to the creation of risk prognoses based on solid indicators did not prevent individual actors in the military from using such systems for preemptive military strikes, i.e. for the proactive prevention of explicitly identified future attacks. Moreover, it also did not prevent them from further developing these systems, as we especially saw with the civilian costs of the US drone program; for instance, with the support of the SKYNET program that was leaked in 2016 and that *"may be killing thousands of innocent people."*[63] The event coding and prediction system *Integrated conflict early warning system* (ICEWS) is also representative of this type of development. The design of the ICEWS was also intended to focus on future suicide attacks and terrorist attacks. Nevertheless, the primary question of this predictive project was: "Can a model predict a war?"[64] ICEWS (2007) was developed by university researchers through financial support from the *Defense Advanced Research Projects Agency* (DARPA) in collaboration with the United States defense and technology company *Lockheed Martin Corporation*. The current version of ICEWS focuses on the IT-supported prediction of political events, such as uprisings, civil wars, or coups. In brief, this system works by obtaining data, primarily from the Reuters' online news feeds, then by combining these with models that correlate behavior of

62 Sharon Weinberger, "Social Science: Web of War," Nature 471, Nr. 7340 (March 1, 2011). 566–68.
63 Christian Grothoff and J.M. Porup, "The NSA's SKYNET Program May Be Killing Thousands of Innocent People," Ars Technica, February 16, 2016, https://arstechnica.com/information-technology/2016/02/the-nsas-skynet-program-may-be-killing-thousands-of-innocent-people/ (accessed 1/8/2024).
64 Sharon Weinberger, "Social Science: Web of War," Nature 471, Nr. 7340 (March 1, 2011). 566–68.

ethnic and/or political groups, economic factors such as the country's gross domestic product, and geopolitical relations with other nations. The resulting output is a so-called ICEWS forecast, which was able to predict the following: *"Country X has a 60 percent chance of entering a civil war."*[65] According to the then DARPA program manager Sean O'Brien, these models were already being used by the *United States Special Operations Command* and *the United States Africa Command* at the time although they had not yet been fully introduced.

Preemption in Modern International Law

International law recognizes neither preemptive wars nor preemptive strikes.[66]

The right to anticipatory self-defense is the subject of controversial debate in international legal studies. The British lawyer and professor for international law Christopher John Greenwood refers to it as perhaps *"the most controversial question"* in the context of the right to *self-defense*.[67] While the concept of preemptive self-defense tends to be approved of in the US, with the citation of customary international law and the right to self-defense, which existed before the adoption of the UN charter and has survived it,[68] the majority rejects the right to self-defense under customary international law. According to the latter, preventative and preemptive military measures are only permissible with the authorization of the UN Security Council.[69] *"A right to preemptive self-defense does not follow from the fact that Article 51 of the UN Charter*[70] *speaks of the 'inherent right to … self-defense.'"*[71] According to the Professor of Law Mary Ellen O'Connell, consensus exists among international scholars of law that preventative

65 Ibid.
66 Ulrich Arnswald, "Präventiv-Krieg oder Präemptiv-Krieg?," der Freitag, August 22, 2003, https://www.freitag.de/autoren/ulrich-arnswald/praventiv-krieg-oder-praemptiv-krieg (accessed 1/8/2024).
67 Christopher Greenwood, "Self-Defence," Oxford Public International Law, (April 2011), https://spacelaw.univie.ac.at/fileadmin/user_upload/p_spacelaw/EPIL_SelfDefence.pdf (accessed 1/8/2024).
68 See Anthony Clark Arend, "International law and the preemptive use of military force," The Washington Quarterly 26, Nr. 2 (2003): 89–103, https://ciaotest.cc.columbia.edu/olj/twq/spr2003/twq_spr2003a.pdf (accessed 1/8/2024).
69 François Campagnola, "La légalité internationale de l'action 'préemptive' et 'préventive,'" défense nationale et sécurité collective (2006), 67.
70 "United Nations Charter" https://www.un.org/en/about-us/un-charter/full-text (accessed 1/8/2024).
71 Scientific Services oft he German Bundestag "Das Konzept der präemptiven Selbstverteidigung aus Sicht der internationalen völkerrechtlichen Literatur," Ausarbeitung WD 2 – 3000-049/07 (2007), https://webarchiv.bundestag.de/archive/2016/0617/blob/414640/44a2b7337d3b8fd94962639cb365c9c8/wd-2-049-07-pdf-data.pdf (accessed 1/8/2024).

defense measures are permissible to a limited extent so long as plausible reasons exist.[72] Regarding the use of early detection and prediction systems, AI researchers Karl-Hans Blaesius and Jörg Siekmann highlight that there are systematic reasons why existing indicators could also be seen as harbingers. If this were to happen, a technical *"system would also be more likely to predict a war (or crisis), potentially exacerbating a situation that is already critical."*[73] Such a hypothetical case clearly illustrates the danger that a military action could be mistakenly carried out to prevent developments by other states that were at an early stage. To address this risk, the internal workings and system properties must be transparent and comprehensible at all levels.

The basis for the interpretation of individual cases are the so-called *Caroline criteria*. These are internationally recognized criteria for the exercising of the *right to self-defense* by states. This right is guaranteed when there is no other choice of means except the use of military force to prevent an attack. This means that every possible avenue of negotiation must have been proven to be exhausted. This is the case – for instance – when an enemy missile attack is imminent, and no time is left to conduct negotiations before the enemy missiles are launched. This means that there would be *no other choice* but to attack to defend oneself. Having no other choice of means therefore implies nothing more than the fact of an imminent threat, albeit a threat that must be substantiated. This is the point at which predictions from technical systems – among other things – are brought into play because plausible reasons must exist to believe that this enemy attack is truly imminent and these reasons must be presented in such a way that an objective observer can understand them. This objective observer is the world public or the UN Security Council. It must be convincingly demonstrated to them that the use of military force was the only remaining means of averting an attack. It must therefore be possible to comprehensibly and plausibly explain under time pressure where and how one arrived at the current discoveries. After the events on September 11, 2001, this clause inevitably led to kind of reinterpretation of the permissibility

72 See Mary Ellen O'Connell, "The Myth of Preemptive Self-Defense," ASIL Task Force Papers (August 2002). P. 8, https://www.comw.org/qdr/fulltext/02oconnell.pdf (accessed 1/8/2024).
73 Karl-Hans Bläsius and Jörg Siekmann, "Computergestützte Frühwarn- und Entscheidungssysteme," Januar 22, 2021, www.fwes.info/fwes-21-1.pdf (accessed 1/8/2024).

of preventative use of force, resulting in the international *"shift in the understanding of immediacy."*[74]

The history of technical systems in supporting the detection of imminent attacks or the history of systems that previously actively defend against them has since its inception faced the challenge that future real-world events must be calculated under unpredictable circumstances. Or, in the words of Norbert Wiener, *"it is exceedingly important to shoot the missile, not at the target, but in such a way that missile and target may come together in space at some time in the future."*[75] In 1948, Wiener was tasked with developing a method to predict the future position of an approaching flying object. He called it the *linear prediction code*. Systems like ICEWS or SCARE apply this predictive function that has an almost 100-year-old history of development to human behavior. The transition from prediction to preemption is inherently ambiguous and poses a considerable challenge for society because these systems also attempt to actively prevent a future continuation before it happens with the aid of their designated predictions. However, within the technical systems, there is a clear disconnect from what they are designed to do, and this is as true of Wiener's air defense system as it is of the aforementioned systems. In both cases, the purely internal modes of functioning are separate from the outside world. For these systems, there's no difference between predictions about missiles, possible terrorist attacks, an imminent wave of refugees, or war. It is only in rare cases where the system's internal decision-making functions can be used to embed their meaning for us in the real world on their own. This often leads to unpredictable errors during operation, which might not always be recognized as such. V.S. Subrahmanian – the developer of the SCARE system that was used to predict suicide attacks in Baghdad, among other things – once stated in an interview that *"I would say the weather guys are far ahead of where we are"*[76] in terms of forecasting. He made this statement to highlight that meteorologists are accused of being wrong as often as they are of being right. In the case documented by Kathleen Carley, the developer of the ORA model (see above), the systemic error in real-world

74 Christophe Eick, "'Präemption,' 'Prävention' und die Weiterentwicklung des Völkerrechts," Zeitschrift für Rechtspolitik 37, Nr. 6 (2004): 200–203.

75 Norbert Wiener, Cybernetics: or Control and Communication in the Animal and the Machine, 2. Edition (Cambridge, MA: MIT Press, 1961). 5.

76 See Sharon Weinberger, "Social Science: Web of War," Nature 471, Nr. 7340 (March 1, 2011). 566–568.

usage was clearly recognizable. *"One of the issues,"* she suggested, *"is that you will get people who are […] part of the networks who aren't alive."*[77] When the ORA model was used in Sudan – for instance – textual analysis of a network revealed that one of the central figures in the network in question was the Islamic prophet Muhammad, who died in 632 AD.

Epilogue

Software systems are referred to as *operationally open systems*. They are not systems isolated from the outer world. Nevertheless, there are differences. Computer simulations or calculations of states of the environs made purely from statistics do not directly lead to changes in the environs. No one would claim that a system like ORA, GOTHAM or SCARE directly intervenes in its surroundings by predicting future attacks or creating a threat index. Nonetheless, when these two systems are directly embedded into intelligent security systems, such as when INDECT launches a drone in the event of danger or a security or moderation system automatically denies access to a flight terminal or the user's account on an internet platform, then the calculations directly entail changes in the system's environs and – in the previously mentioned cases – these have a significant impact on daily lives. It is in this realm that the previously closed system becomes an open one. This is a system that not only exists in its respective surroundings and is thus able to exert influence there but also one that engages in constant exchange with its surroundings and having a direct impact on them. Open systems are therefore systems that react to environmental conditions by absorbing information from the surroundings; they are embedded in the real world and alter it through their own activity. In a sense, they modify a reality that they have modeled.

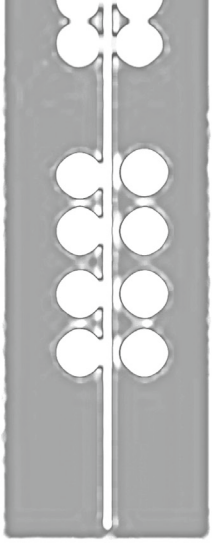
The technical systems explored in this article increasingly refer people (as users) to this modeled reality – or in systemic theoretical terms – the outside. The extent of this localization depends on the transferring of agency to the system through various forms of interfacing the human-machine interactions. These veritably lead to a fusion of preemption and technical prediction, of open and self-contained, *closed systems*. *"The modification of reality (in this fusion)*

77 Ibid.

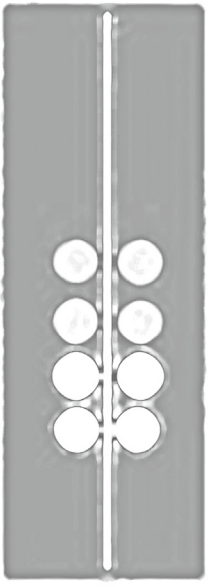
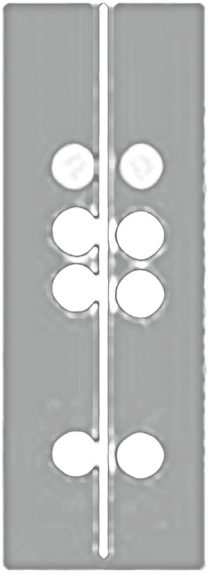
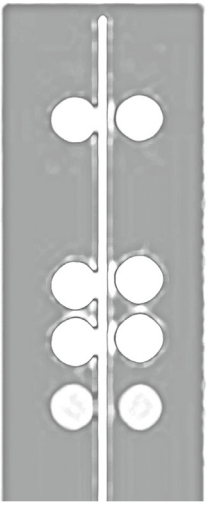
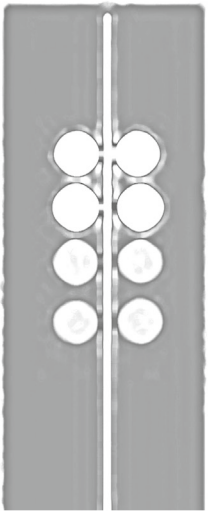
does not necessarily have to take place through direct actions, as in robotics, but will typically be indirectly effective by changing the perspectives and workflows of the users."[78]

Our collective experience in this century is shaped by decisions that we make in dealing with digital technologies, and we bear the responsibility of ensuring that these decisions align with our inner and social values, as well as with basic human rights. It is only by maintaining a critical distance that we can collectively shape a future where technologies, which were developed to predict our future from the idea of crises, enrich our lives without jeopardizing our fundamental rights.

78 Georg Trogemann, Jochen Viehoff, CodeArt (Vienna: Springer-Verlag, 2005). 37.





When the scholars run out of Latin, the magicians take the stage.
unknown

Georg Trogemann

Software and Magic

Or an attempt to re-enchant the world

Technical ignorance

Rationalisation through science and science-oriented technology has not resulted in people today knowing more about the conditions in which they live than those in the past. Rather, it only means that we could know more if we had the time and inclination to engage with it. As such, most of us do not know how the myriad of gadgets (mobile phones, fridges, ceramic hobs, electric cars, etc.) that we use as a matter of course every day actually work, nor how modern materials (building, raw, synthetic and adhesive materials) are produced, let alone how certain chemical substances (medicines, vaccines, drugs) take effect in our bodies. At most, we have a vague idea. However, we are convinced that there is no magic whatsoever at play and that there are in fact people who understand each respective principle at work quite precisely. It is the task of science to decipher things in the places where we do not yet understand phenomena. Max Weber already highlighted this paradox in our technological existence in a speech in 1919: "Thus the growing process of intellectualization and rationalization does not imply a growing understanding of the conditions under which we live. It means something quite different. It is the knowledge or the conviction that *if we wished* to understand them we *could* do so at any time. It means that in principle, then, we are not ruled by mysterious, unpredictable forces, but that, on the contrary, we can in principle *control everything by means of calculation*. That in turn means the

disenchantment of the world."[1] An interesting question that Weber leaves unanswered is: Can we really know how things work, or do we only believe – as modern enlightened humans – that we have the potential to know it?

Trust in a better future through technological advancement – which characterised the whole of so-called "technocratic high modernity"[2] – is dwindling. Nonetheless, we are dependant on technical innovations to solve the climate crisis, which is itself a direct consequence of our highly technological way of life. Taking a closer look at informatics, we find what is probably the greatest promise of prosperity and progress since industrialisation hidden behind the keyword of "digitalisation." Nothing seems to be able to escape computation by algorithms. Even before "technocratic high modernity" – dated from 1880 to 1970 – began, the conviction grew amongst engineers that not only is technology itself subject to calculable principles, but also the invention of technology, which until then was governed by the magical moment of intuition, can be subjected to mathematical principles. In the 1840s, the engineer Robert Willis occupied himself with the development of mechanisms, that is mechanical constructions, with which any movement relationships between a number of fixed elements could be realised. He was convinced that there were better ways to achieve good mechanical solutions than leaving it down to the intuition of engineers, writing, "there appears no reason why the construction of a machine for a given purpose should not, like any usual problem, be so reduced to the dominion of the mathematician, as to enable him to obtain, by direct and certain methods, all the forms and arrangements that are applicable to the desired purpose, from which he may select a pleasure. At present, questions of this kind can only be solved by that species of intuition which long familiarity with a subject usually confers upon experienced persons, but which they are totally unable to communicate to others. When the mind of a mechanician is occupied with the contrivance of a machine, he must wait until, in the midst of his mediations, some happy combination presents himself to his mind

1 Max Weber, "Science as a Vocation," (1919) in: The Vocation Lectures, eds. David Owen and Tracy B. Strong, trans. Rodney Livingstone (Indiana IN: Hackett Publishing Company, Inc., 2004), 12–13. Weber compares the knowledge of his contemporaries with that of "Indians, Hottentots and savages." Problematic from today's perspective, but he does not value the knowledge of these groups any less than that of his listeners.

2 Uwe Fraunholz and Sylvia Wölfel, eds., Ingenieure in der technokratischen Hochmoderne, Cottbuser Studien zur Geschichte von Technik, Arbeit und Umwelt, Vol. 40. (Münster/New York: Waxmann Verlag, 2012), 9.

which may answer his purpose."[3] Without being called so, this is already the description of an algorithmic space of possibility that contains all of the solutions for a specific problem. Indeed, this is a very current perspective that we will return to later.

Today, we find ourselves in a situation in which we, depending on our occupation, might know the operating modes of the technology in our area, but no longer have a general understanding. In fact, this can no longer really exist due to the complexity of technical scientific knowledge. We are surrounded by a myriad of black boxes and all that is left to us is to trust that those we call experts have weighed up the risks and rewards of respective technologies for the common good. At times this goes wrong. In the first 50 years of the use of nuclear energy, there have already been two "beyond-design-basis" events, which – according to the experts – should only occur every 10,000 years at most. While our early ancestors were subjected to a nature that was wild and inexplicable, we largely have these historical dangers under control, we live in cultural landscapes where even the sighting of a single bear or wolf can trigger a major media event. What we now colloquially call wilderness only exists as a residue in protected reserves. In return we see ourselves increasingly exposed to the dangers of untamed technology that we do not understand. The philosopher Peter Sloterdijk thinks we are delusional if we understand early human societies as helpless. "In reality, modern human beings' range of competence has expanded so much that they are far more at risk of helplessness than prehistoric human beings. They are more often at risk of failing through incompetence, and on more fronts. Early humans, by contrast, benefitted from having a grasp of almost everything they needed for their personal and social sustenance, while they managed everything they lacked the skills for more or less routinely with the protection of rituals."[4] In this reading, magical rituals such as the recitation of a song for the weather god during a storm are an effective technique "to stay in good spirits in bad weather." Moreover, "magic is nothing other than the generation of optimism and the believed repulsion of damage and misfortune."[5]

3 Robert Willis, Principles of Mechanisms (London: John W. Parker, 1841), III-IV.
4 Peter Sloterdijk, "The Right Tool for Power: Observations on Design as Modernization of Competence," in: The Aesthetic Imperative (Cambridge and Malden: Polity Press, 2017).
5 Erhard Schüttpelz, "Magie und Technik," Zeitschrift für Kulturwissenschaften: Homo Faber, no. 2 (2018), 44–45, https://doi.org/10.25969/mediarep/13885

The belief that the world is – based on science – understandable and controllable and thus that our future can be shaped in key points is deeply implemented in our Western culture and is the most important motor of technological advancement. Thereby, perspectives other than prosperity and security achieved through technological progress are quite possible. Technical inventions open up new spaces of action and experience to us and in so doing something magical is also always in play. Clarke's third law – according to which any sufficiently advanced technology is indistinguishable from magic – is an adage well known far beyond the world of science fiction. The question of whether it is difficult to understand technology because today's knowledge can not be handled quantitatively, or because there are actual basic epistemic boundaries is not an easy one to answer. The latter would mean that the disenchantment of the world proclaimed by Max Weber is based on an error. With a view to algorithms and digital technologies, in the following an attempt will be made to at least deliver clues concerning why this question is so problematic. For some phenomena, the label *"magic"* may prove more fitting than "rational" or "causal," not only from the current perspective – because we have not yet understood it – but also in the long term.

The historical world view and digital technology

In an interview on the fringes of the series "AusZeit,"[6] organised by Vodafone Institut für Gesellschaft und Kommunikation Berlin in 2016, the literary scholar Hans Ulrich Gumbrecht spoke of the explosion of possibilities in thinking, planning and acting created by current electronic communication systems and computing power in general. However, the rapid growth in options through "the fusion of software and consciousness" brings not only increased freedom, but is also overwhelming for all of us. He often observes that his own children, who are in their mid twenties, need the whole of Thursday to choose from all of the options for Friday, Saturday and Sunday. Subsequently, when Friday, Saturday, Sunday comes, there is constant doubt: "can't we perhaps do something else or shouldn't we have done something else." It is his impression that the weekends often fail because, unlike in the past, there are so many possibilities.

6 Hans Ulrich Gumbrecht in conversation with David Deißner on the fringe of the series "AusZeit" in Cafe Einstein Stammhaus, Berlin 2016. Organised by Vodafone Institut für Gesellschaft und Kommunikation.

A quite plausible suspicion that with the objective increase in leisure time options, together with media networks constantly informing us about them, a subjective unease grows that the party is always happening somewhere else.[7] The problem is that choosing one of the alternatives eliminates all of the others. The vague promise that resides in the plurality of possibilities collapses in the moment of decision and the loss sustained increases with the size of the offer. This that means you can only make the wrong decision. Gumbrecht's observations – in which his polemic distance to digital technologies is also expressed – are part of a comprehensive diagnosis of the present. Under the term "chronotope," which targets our social and cultural constructions of temporality, he contrasts two different concepts of time: the chronotope of "historical time" – also called the "historical world view" – and the new chronotope of the "broad present," which according to his thesis has appeared since the second half of the 20th century. In the following, these two cultural concepts of time should help us achieve a better understanding of two different programming paradigms in digital media.

According to Gumbrecht, "historical time" is the specific chronotope that understands time as the necessary agent of change.[8] Gumbrecht believed that this understanding of time as a transcendental principle and effective power of change – which arose at the same time as the humanities – was so strongly institutionalised in Western culture between 1830 and 1980 that it was taken for the true über-historical concept of time, for time itself. Due to a lack of space I will not try to retrace his argumentation as to how we reached the formation of the still widely canonised historic world view, instead I limit myself in the following to a brief presentation of the essential features from his perspective.[9] It is first the world view from which we believe we can leave every worked-through past behind us and that its orientation value for the present fades, the further we leave it behind us. Second, it is the world view in which the future is an open horizon of possibilities to be shaped by us humans. Third, the present shrinks to a short, no longer perceptible moment of transition between the past that you leave behind you, and

7 Cf. Fear of Missing out (FOMO), accessed September 17, 2023, https://en.wikipedia.org/wiki/Fear_of_missing_out
8 Hans Ulrich Gumbrecht, "Zeitbegriffe in den Geisteswissenschaften heute," in: Zum Zeitbegriff in den Geisteswissenschaften, ed. Österreichische Akademie der Wissenschaften (Vienna, 2017), 6f.
9 Cf. Ibid. 9f.

the future, that is yet to be formed. Gumbrecht adds another two to these three perspectives adopted from historian Reinhart Koselleck. Fourth, the imperceptibly brief present becomes the epistemological place of the subject, that is the place "where people consciously adapt experiences of the past to the present and choose from the possibilities of the future on this basis, thus shaping the future,"[10] which we call "doing" since Max Weber. Fifth, we assume in the historical world view that time is a necessary agent of change and there are no phenomena that can evade change. Ultimately, it will always become apparent how a logical necessity is inherent in all changes. According to Gumbrecht, the historical world view was constitutive for the humanities as a whole because it co-emerged with it. Without this notion of time the philosophy of history or literature or art history would not have been possible, nor would capitalism or socialism, which have the necessity of an open future in common, be conceivable.

How does technology – especially informatics and digital technologies – behave with respect to this world view? Gumbrecht refers explicitly to the humanities with his diagnosis of two central concepts of time. For technology, the idea of progress, which accompanies the implementation of the rational world view and represents a guiding principle of modernity, is central. The idea of progress is also reliant on the notion of an open, shapable future as its inner driving force. While the production of meaning, comprehension, and interpretation are essential in the processing of the historical world view that the humanities undertake, for technology just as design, it is about doing, i.e. the production of material facts. Both humanities as well as technical sciences refer to the same linear time arrow, but they concentrate on different sections of the temporal axis, there the past, here the future. In technology it is not primarily about the valuation and interpretation of the present or past, but rather the poietic production of the future. Pragmatic realism is required for the design of the future to succeed, or as Robert Musil puts it, "To pass freely through open doors, it is necessary to respect the fact that they have solid frames."[11] Only technologies that pass the reality test are viable. Trivially, an invention is only an invention if it

10 Ibid. 10.
11 Robert Musil, The Man Without Qualities. trans. Sophie Wilkins (London: Picador, 1997).

also works, that is, it manages to stabilise material processes so that an intended functional behaviour sets in that is replicable at any time. Casual relationships and the overcoming of material obstacles are decisive factors here. The skills necessary for this are not exhausted in epistemic knowledge, it is much more that a new phenomenon is established that not only really exists as an object, but also whose production is communicable and teachable and whose use generates new patterns of action and habitualisation. Epistemic knowledge is needed especially in the developmental phase, which is still concerned with the control and consolidation of technical phenomena, and it increasingly disappears with the formation of habits. In this context, inventions are to be distinguished from innovations. In order to speak of a innovation, it is insufficient to present a technical novelty, but it must also be successfully implemented. It is innovations that ensure that technical products become obsolete and eventually disappear again from our social environment, until they ultimately belong to the museum of the technical past. One talks in this context of disruptive innovations when products radically change existing structures and whole markets within a short period. In the digital realm this has led to the explosive growth in possibilities of thinking, planning and acting described at the beginning. Therefore, fundamentally the historical world view, with its division into past, present, and future, whereby the present of the place of action and time are the operative principles behind all change, can also be easily identified as a formative background foil in the development of digital technologies.

This general picture is to be complemented in the following by three summaries specific to digital technologies.

Past: In the world of the computer, the past is identical to that which exists in the digital present. All data and algorithms stored at a certain moment belong to the past of this computer or network. That which escapes digitalisation simply does not exist and is thus neither past nor can it, through further computations, be part of the future. In order to maintain and optimise their own functioning and at the same time allow reasonable handling of the past and reconstruct incidents and processes in sufficient precision, digital systems permanently log their own operation. The question is then, which previous incidents can be reconstructed from this data and

which future occurrences can be predicted. However, where there is no data, there is also no past. Storage technologies immediately split occurrences into two categories, the recorded and the not recorded past. From a forensic perspective it makes a difference whether data exists or not. If a mobile phone registers in a radio cell at a certain time, this certainly allows conclusions about occurrences outside the computer. How the data is connected with the world is also decisive. The integrated backup function of Mac computers is called, for quite obvious reasons, Time Machine. If data is accidentally deleted or the computer has a defect, the system can, at any time, be restored to an earlier state. The time between malfunction and the last backup no longer exists from the perspective of the computer. Generally speaking, only that which has left traces in the present, in the archives, nature, the heads of people or in the case of electronic media in the digital data, can become the past. This data can now be analysed, interpreted, and provided with sense and thereby also be used for the planning and forming of the future from ever new perspectives. This is not meant in the classical hermeneutical sense, but rather in an algorithmic sense. The meaning of data is identical with what the respective algorithm makes of it, very similar to the Wittgensteinian language game, where the meaning of a word is identical to its use in language.

Present: Digital processors are clocked, that means there are only defined states in the brief moments of synchronised standstill, of non-operation. Current processors are clocked with 2 to 3 GHz, so the system finds itself in a defined state 2 to 3 billion times in one second. During operation itself, the state of the processor is not defined. The present of the computer is made up of those tiny moments between the individual steps of computation. In every second, billions of tiny pasts are thus created. Depending on the executed operation, the system accesses stored data, pasts of the system from long ago, and creates the successor state according to deterministic rules. Here nothing is left to chance. The mechanism of the clock signal is developed precisely to eliminate uncontrollable physical variations and thus sources of ambiguity, which in theory limit the precision of computation in unclocked analogue computers. What we call digital is realised on the undermost level of circuits. The quick sequence of discreet presents does not allow

ambiguities or scope for interpretation, it is a mono-perspectival system. In the theory of informatics, there is a special class of machines in the finite automata that know no past. The next state depends here exclusively on the momentary state of the machine, no earlier values flow into the calculation. When the system finds itself in a certain state, the way this state was reached plays no role for the future of the system. All of the past is thus irrelevant. It is easy to show that finite automata are a sleek and powerful concept, but that they do not achieve the computational power of automata with memory (e.g. Turing machine, pushdown automaton), which can access prior incidents.

Future: One might think that the future of computational processes can hide no surprises. After all, we already know from the algorithm, in the greatest possible accuracy, the steps that the system will execute in the future and each one of which runs completely deterministically. In interactive uses, where external agents intervene in computation, the form of intervention is already anticipated and the reaction to it defined in the algorithm. In many cases, the behaviour of computation processes can indeed be predicted through an exact inspection of the programme text that codes the algorithm. However, algorithms can just as easily be written that, despite being only made up of a few lines, are opaque or about which certain principle statements can not be made at all. One can also ask questions of algorithms that are difficult or impossible to answer in the code itself. For one class of algorithms, the halting problem, the question, of whether the computation reaches an end or not, is only partially determinable, so only by letting the algorithm run. Decisive here is that there is a qualitative difference between the written algorithm – the programme code – and the process of its execution. In this context chaotic (non-linear) dynamics that show a special sensitivity to the initial conditions are also interesting. Many laws of nature – for example – can be formulated as differential equations and simulated with a computer. Predictions about the future behaviour of the system can then be made based on this model. However, the long-term development of these systems over time is not predictable, although the underlying equations are often very simple and completely deterministic. If the identical model (programme) is run on two different computers, even the word length of the computer

used can decisively influence prediction results. Even from these brief observations on predicting the future behaviour of algorithms it should be clear that algorithms have a difficult relationship with questions of prognosis.

The broad present

> *But if there is such a thing as a sense of reality – and no one will doubt that it has its raison d'être – then there must also be something that one can call a sense of possibility.*
> *Anyone possessing it does not say, for instance: Here this or that has happened, will happen, must happen. He uses his imagination and says: Here such and such might, should or ought to happen. And if he is told that something is the way it is, then he thinks: Well, it could probably just as easily be some other way. So the sense of possibility might be defined outright as the capacity to think how everything could 'just as easily' be, and to attach no more importance to what is than to what is not.*[12]

According to Gumbrecht's conviction, we have "for a long time, lived our daily lives under a social construction of time that has nothing to do with the historical world view. […] In this other world view, which, I think, dominates global everyday life today, the future is in no way an open horizon of possibilities that we can shape, but rather one filled with dangers that seem to head towards us inexorably. Global warming, for example, the end of resource reserves, demographic development."[13] Through globalisation and not least due to electronic storage and communication media, the past is also not a dimension that we can understand, work through and leave behind us in this new understanding of time. From his perspective, the past permanently floods the present, which is now no longer an infinitely brief moment of transition, but rather a widening present of simultaneities. While the brief present of the historical world view, in the sense of the Cartesian "cogito, ergo sum," was self-referential and related to consciousness, we will now endeavour to incorporate sensuality and the body back into our self-reference. In the broad present, time has lost its former directionality, so we are constantly active and permanently in a state of transmission and reception, in multitasking mode, yet this hectic state no longer develops dynamism in terms of a change of circumstances. "In any case, this present becomes a universe

12 Ibid.
13 Gumbrecht 2017, 11f.

of contingency, an endless range of perspectives and possibilities. Which implies incredible amounts of freedom, but perhaps will also become an existential overload for us as individuals."[14] Because the broad present includes everything and all of the past is cancelled within it, according to Gumbrecht, it does not lead to the displacement of the historical world view but rather a parallel existence.

Following Gumbrecht's argumentation, the broad present dominates global daily life, in the historical sciences as well as the technical sciences, which are in turn inextricably entangled with politics and economy, but the historical chronotope still reigns. From what I can observe, especially regarding the uncontrollable, risky future, such as aforementioned climate change, there is now an even greater concentration of scientific and socio-political efforts aimed at keeping negative impacts in the future as minimal as possible. Research areas such as speculative design, which primarily deals with speculative futures and strives for the expansion of (also unreal) spaces of possibility, sees itself exposed to keen criticism in light of urgent problems. The drafting of new collective world views and patterns of behaviour, which mean a quicker and tangible change in everyday life, is currently at the centre of design interest. Here we can see a concurrence of chronotopes rather than the replacement of one by the other. The more that one tries to understand Gumbrecht's chronotopes, the greater the doubt concerning whether this proposal really clarifies the current situation. However, whether his diagnosis strikes at the core of our present social condition is not at all decisive for the following considerations. Not only are his chronotopes suitable for characterising two historical world views, but they can also help to illustrate two fundamentally different views on algorithms. One can also use these different perceptions of time and the handling of scopes of possibility to look at the development of software.

I would like to call the default setting that underlies professional software development to this day the Chronos paradigm. Here the development of software takes place in a more or less standardised framework so that the complexity of processes is kept manageable. All of the common procedure models of engineering application

14 Ibid. 12.

development today belong to this paradigm. In order to retain control over the development process, it is divided into manageable units, limited in terms of time and content. The Chronos paradigm also strictly follows the guiding principles of a disenchanted world outlined by Max Weber. Everything is computable or is made computable, nothing can permanently evade the grasp of the algorithm. The focus is the targeted solution of problems. All effort is geared towards the future, progress, and the improvement of products. In this, actors follow the conviction that what they are dealing with is, in principle, understandable, controllable, and ultimately also computable. This begins with the specification sheet, which already tightly defines the aim. Considerable energy is invested in planning to maintain control and assure the achievement of the predefined result. Realisation takes place on a deterministic machine, whose overall behaviour stems from the controlled succession of precisely defined elementary steps (operations). Computing and understanding are largely seen as the same here. It is about causal thinking and the juxtaposition of possibilities, i.e. Robert Musil's realism dominates events.

The software philosophy that I will call the Kairos paradigm follows a fundamentally different objective. It is no longer about evaluating the initial situation and enforcing desirable conditions in the future through suitable actions in the present, but rather about giving up control and thus gaining freedom. More precisely, it is about the production of scopes of possibility in which something new can occur. It is not the sense of reality that is central here, but rather the sense of possibility. Instead of cybernetic control, i.e. the targeted control of a predefined result, it is about a lucky discovery. Just as for Musil the sense of reality and the sense of possibility are not a statement about the structure of the world, but rather only that it can be encountered with different attitudes which accordingly leads to different results, Chronos and Kairos philosophy in programming say nothing about the basic structure of the digital computer. In the Kairos take, in line with the myth around Kairos, it is about recognising opportunities at the right moment and grabbing onto them. However, in order for favourable opportunities to arise, the digital spaces of possibility for it must first be produced by software. The creation and growth of possibilities are not seen here, as with

Gumbrecht, as a problem, but rather as an essential prerequisite to escape the disenchanted world. Overwhelming through surplus is a condition of success here. However, abstract spaces of possibility in the memory of a computer are not yet phenomena. Possibilities must present themselves to the senses, they have to be made observable and perceptible. Here it becomes clear that perceptions, occurrences, and experiences always depend on perspective, of which there are potentially an infinite amount. Therefore, in media generated phenomena, two ways of appropriating the world always interact: appropriation through concepts – through symbols and abstraction – and adoption through the senses and the body. Computer scientists normally prefer the former, artists the latter.

Yet another problem presents itself alongside the question of how digital spaces of possibility are to be constructed. We must decide how we wish to use this approach to escape the "loss of materiality" that forms the actual centre of Gumbrecht's time diagnosis. The disenchantment of the world is not least a result of excessive abstraction. The character of digital media is to reduce the whole world to a play of symbols. The world of programmers is largely made up of their skilful movement through hierarchical layers of symbol systems and formal structures. In coding in particular this means a short-circuit of consciousness and software and the complete exclusion of the outside world. What Gumbrecht calls "presence," so spatial proximity and substance, lapses almost completely. In line with the idea of re-enchantment, we must also question which fundamental potential connections between software and the world can be realised and how physicality and concrete physical materiality can be brought back into play. Before we look closer at how the Kairos paradigm can answer these questions, we should clarify the conditions under which one can even talk of re-enchantment – namely magic in technology – in further detail.

Magic and technology

> *Magic is objectification within an order that is felt as objective and assumed as objective. That this order seems to foreigners and outsiders as, in part, imagination, has nothing to do with this precondition of objectivity, as our objectivities and their legitimations too, presented in absolute conviction, already appear as subjectivities within a few decades.*[15]

Magic claims to be able to achieve supernatural effects through more or less ritualised actions. In contrast to technological action, a special ability that is not widely accessible is required. The literature on the topic of magic is vast and the current article can in no way do it justice. I will therefore limit myself to the presentation of a few aspects that seem to me as sufficient justification for the use of the term in the title of the article. First, I wish to name – with close reference to Markus Walther – some similarities in the patterns of action of magic and technology.[16] The first important feature is that in both cases it is about action that pursues a purpose, that is not performed as an end in itself, like the playing of a musical instrument. Both magic and technology have genuine poietical character, they are about the attainment of very worldly aims, like the provision of material goods, power, prosperity, fertility etc. Both also strive for the expansion of the effectiveness of human action. For the layperson, the aims initially appear unachievable, yet the actors in both cases manage to acquire control and certainty over the objective. However, in this it is important that binding patterns of action are followed. The processes are strictly regulated, the individual steps are to be carried out carefully and precisely. Failure to comply leads to the desired outcome not being achieved or only being unsatisfactorily achieved. Both the magician and the technician are faced with scepticism from society, as we do not know how they accomplish their work. Each requires special skills and we fear the negative consequences in both cases. Summarising, according to Walther, it is about "action that is expertise-needy, rational-outcome oriented and control desiring."[17] Parallels between the two practices certainly present themselves to the outside observer. This poses the question of how we can differentiate technological and magical efficacy with certainty.

15 Schüttpelz, 2018, 44–45. DOI: https://doi.org/10.25969/mediarep/13885.
16 Cf. Markus Walther, "Magie und Technik: Parallele Denkungsarten?" accessed September 6, 2023, https://www.vergleichende-mythologie.de/magie-und-technik-parallele-denkungsarten/.
17 Ibid.

Comprehension can provide a key to such a distinction. In the classical division, technology follows a rational paradigm of cause and effect, while magic goes beyond the laws of nature and can no longer be explained by reason. However, magical actions also follow causal ideas. Ninian Smart distinguishes between "devic" and "mantric" causality models to explain the connection between ritual acts and the results obtained.[18] In the devic model, the agent turns to a god who is to be appeased, in the mantric model, on the other hand, the action itself brings about the result. However, everyone knows there is no relying on gods. The more reliably the ritual works subjectively, the more pronounced its mantric character. Whether the underlying causality also exists from a scientific perspective is irrelevant, the subjective conviction that the ritual works is decisive. In the default scientific view, magic is an illusion, subjective and not in accordance with the facts, while technology is based on objective laws, which apply independently of the specific actor. However, according to Schüttpelz, who in turn follows Marcel Mauss and Claude Lévi-Strauss in his account, the attribution of objectivity and subjectivity to magic and technology can also be thought of inversely. "Technology is a subjective effect on the world that remains and becomes aware of its subjectivity, i.e. its own volitional acts, its own capriciousness and the arbitrariness and human evoked artificiality. Magic, on the other hand, understands itself, due to its cosmological foundation, as an intervention on an objective basis. Magic refers to how the world is built up and it integrates itself in this structure. Therefore, in most cases, we can not speak of a striven for intervention, rather a self-integration, a non-intervention or a conscious objectivisation of its own action."[19] Indeed, as Schüttpelz also highlights, the notion of technology as a subjective impact on the world, which is subject to a decent amount of capriciousness, fits better to the traditional European view of technology. The "techné" of antiquity was about the formation of subjective und intersubjective skills and not one "theoria" or scientific objectivity absolved of its usefulness. The form of reason of "techné" is "poiesis," not "theoria." Technological actions are arbitrary insofar as the decision as to which technologies are developed and which purpose they serve is made subjectively or intersubjectively and does

18 Ninian Smart, *Dimension of the Sacred. An Anatomy of World's Beliefs* (University of California Press, 1999).
19 Schüttpelz 2018, 45.

not stem directly from realisable possibilities. Technology is always part of the open future horizon that we can shape.

We can pick up here and go deeper to separate technical and magical efficacy precisely. For this purpose, it is important to identify which knowledge and which concept of truth is at work in technology, or rather poietic action. In my view, the philosophical theory of pragmatism, which measures the value of a theory on the practical uses and consequences it yields, provides the most convincing explanation here. Classic American pragmatism also assumes that all theoretical knowledge arises from practical interaction with things and is fundamentally fallible, whereby rationalistic ultimate justifications are rejected. According to William James, in pragmatism, agreement with reality "means verifiability. Verifiability means ability to guide us prosperously through experience."[20] In this context, truth is nothing more than a collective term for verification processes and is created in the course of experience.[21] In this sense, technological development processes are permanent verifications of theories. As long as everything goes well, i.e. everything goes as expected, this confirms the underlying theoretical notions. Only when something unexpected happens, things no longer work as they should, do the ways of thinking that guide action also become questionable. The most important function of theory in technology is that it expands the framework of action and allows predictions even in changed conditions. Theories are feats of abstraction, that means the superfluous is left out and the matter is reduced to the main variables. Successful abstractions therefore enable very different situations in practise to refer back to the same principle. It is this variability in science-led technical thinking that makes it possible, in combination with practical experiences, to make statements about expected behaviour and thus develop the engineer's massive range of action. It is not a question of whether the theory used corresponds with reality or eternal, definitive truths. As Hans Vaihinger already identified in 1877 in his philosophical postdoctoral thesis *Logische Untersuchungen. I. Teil: Die Lehre von der wissenschaftlichen Fiktion* (Logical Investigations. Part 1: The teaching of scientific fiction), science always works with false assumptions and ideas, which he

20 William James, *Pragmatism: A New Name for Some Old Ways of Thinking* (1907), (Project Gutenberg EBook, 2004), accessed September 06, 2023, https://www.gutenberg.org/files/5116/5116-h/5116-h.htm.
21 Cf. Ibid.

calls fictions. For Vaihinger, fictions are notions that we know are not durable and for which we can find no representative in reality; for example, our notion of atoms. However, in his philosophy of "as if," it is not about freeing oneself from these consciously false ideas, but rather recognising the necessity of these fictions and understanding them as tools that enable thinking in the first place and working with them. This is a useful characterisation of the function of theory, especially for technology and technical action. For example, fire can be ignited in different ways. Regardless which method we choose, we must master the necessary movements. Those lucky enough to own a lighter can reduce the act to a short movement of the thumb, while the remaining knowledge about fire as a chemical process is built into the lighter. The methods of making fire as a goal-oriented act are learnable and communicable and one does not need to know all of the chemical-physical processes involved. At the same time, when action is concentrated on an objective, the side effects slip out of view. The effects on our ancestors of being able to control fire were considerable and certainly not planned for intentionally. The preparation of food changed completely, the heat killed bacteria and parasites, fire offered protection from animals and had a social function as a meeting place. Not least the change in diet prepared the ground for the growth of the brain etc. The practical knowledge needed to produce an artefact and the knowledge we need to understand the effects and the significance of the artefact within its use context are completely different. Being able to do something does not mean fully understanding it at the same time. In short, technology is poietic in its basic structure, it is primarily about doing, not about propositional knowledge, sense, or understanding. Theory plays a role in production insofar as it helps to generate new ideas for technological developments, guide the technical process and achieve the desired results.

So much for the general relationship between technology and magic. One can thus only talk of magic in the context of digital technologies where there are fundamental gaps in explanation. Therefore, where phenomena occur that are quite reliably reproducible, but which are not understood. To this end we must first briefly recall the basis of the digital computer. The foundations on which the whole construct of the digital is built are abstract symbols and operations.

Both are realised by the electronic hardware, which programmers do not need to worry about, as their thinking starts at the symbolic level. This symbolic machine construct has its origin in mathematics, which had shown that two symbols and a few basic operations is sufficient to produce every structure that is realisable with symbols. The necessary elementary operations are simple and easy to understand by anyone. In order to understand the complex play of symbols, it is decisive that both the operands (the symbols that are processed), as well as the operators (the rules according to which the operands are transformed) are coded in the same repertoire of symbols (0 and 1). The symbols themselves only mark out differences that allow distinctions to be made, otherwise they are empty. In fact, we must now comprehend this construct of operands and operators, that is completely deterministically defined and is occupied by no further prior meaning, as an autonomous system, far beyond mathematics in its potency. Only when we recognise this very particular reality of the digital can we understand how it was able to unfurl such power over the past decades. Numerous further layers of symbolic systems are realised on the electronically realised calculation of the undermost layer, which is only made up of two symbols and a few deterministic operations, whereby the connection between the layers is in turn realised by symbolic systems (general transformations, e.g. compiler or interpreter). The most important symbolic layer in this hierarchy for the continuing development of uses are higher programming languages, which provide not only complex data and control structures, but also programme libraries for the programmers. Therefore, we are dealing with a complex configuration of interlaced symbolic systems, in which constant chiastic switches between operators and operands take place. What is an operator in one model, is treated as an operand by other models, and so on. At the same time, we can integrate the most varied of connections to the outside world in this play of symbols. Only through these connections with the world are the meaning of symbols realised.

Where should explanation gaps open up and phenomena arise that we can fundamentally no longer understand in this complex but, in general, strictly deterministic play of symbols? In fact, several principles can be identified that stubbornly resist the understanding of programmers. Here it is also of little use to refer to the fact that

technology follows a rational paradigm and that it is the duty of the programmer to understand what they are doing. Programmers are clearly the authors of that which arises and the processes follow deterministic rules, yet the result is surprising and only to be evaluated by letting the programme run. The causes of these obstacles to understanding are simultaneously the basic characteristics of algorithms:

Interlaced operations within a level: even the simplest of rules can, with variables that have strong interdependency, create very complex behaviours. This was already the central theme of Stephen Wolfram's 2002 book *A New Kind of Science*.[22] The core theses for Wolfram are: 1) the nature of computation can only be experimentally explored; and 2) the results of these experiments are of general importance for the understanding of the physical world. The impenetrability here is a consequence of dependencies between the operands (data). As the following example class shows, operators can also be included in the game. There is a qualitative, insurmountable difference between the rules and the process that defines the rules.

Change of perspective or level: The hallmark of *"evolutionary algorithms"* is that they abstract the biological basis of evolution, in which individuals arise through mutations over many generations and those which are viable in their respective environment reproduce. For example, in "genetic programming," which also belongs to this algorithm class, programmes develop other programmes. Many instances of further programmes are created at random from one programme. The generated programmes are only operands from the perspective of the generating programme. However, the generated instances are then run to determine their performance, namely how well they solve the predefined problem. In this "environment," in which they must prove themselves, they are also active as operators. Only the most successful programmes are chosen for mutations and for the creation of the following generation. Which programme codes arise after a series of generations is completely unpredictable. The most varied of methods of "machine learning" (neuronal networks, reinforcement learning, evolutionary algorithms, genetic programming) can be assigned to this area of changing perspectives

22 Cf. Stephen Wolfram, *A New Kind of Science* (Wolfram Media, 2002), accessed September 9, 2023, https://www.wolframscience.com/nks/.

or levels. A hallmark here is the chiastic operator-operand switch, that takes place between the programme modules involved.

Connections to the outside world: As long as we remain on the level of symbol and symbolic systems, we can only observe their formal structures. However, as soon as the outcome is materialised as a sensual perception offer for the user (as an image on a plotter, screen, as sound in a speaker, as the movement of a robot arm etc.), a further semantic hole appears, which can not be closed causally. Frieder Nake speaks here of the unavoidable double existence of computer objects, which he calls, in the case of digital images, undersurface and surface.[23] The surface is the image that shows itself to the user, the undersurface is its digital representation in the computer. The meaning of the surface of the image is an individual and singular interpretation of the viewer. "In the interpretative power of a person, the whole culture that they belong to takes effect in an opaque and certainly non-causal way."[24] This view can be generalised regarding the connections between technology and the living environment of the user. The post-phenomenology of the American philosopher Don Ihde thus concentrates on the question of how technology influences the relationship between human and world, in others words how it structures our experience and self-image.[25] This approach, which is currently being intensively discussed and developed by an international scientific community, is also vitally important to our thinking here. The – in itself – meaningless play of symbols in the computer connects here with the body and the senses and intervenes deeply in the experiences and the self-image of the subject. "Humans and the world they experience are the products of technical mediation, not just the poles between which the mediation plays itself out."[26]

Another term – albeit no less controversial than magic – which is capable of characterising the three areas of explanation gaps, despite all their variety, is emergence. One talks of emergence when new properties appear in a system that emerge from the

23 Cf., Frieder Nake, "Zeigen, Zeichnen und Zeichen. Der verschwundene Lichtgriffel," in Mensch-Computer-Interface: Zur Geschichte und Zukunft der Computerbedienung, ed. Hans Dieter Hellige (Bielefeld: transcript Verlag, 2008), 121– 154.

24 Ibid. 126

25 Cf., Don Ihde, *Technology and the Lifeworld. From Garden to Earth* (Bloomington: Indiana University Press, 1990).

26 Peter-Paul Verbeek, *What Things Do. Philosophical Reflections on Technology, Agency, and Design* (University Park: Pennsylvania State University Press, 2005).

interaction of its elements. The emergent properties of systems are direct consequences of interaction (e.g. the local rules of a cellular automaton), but they can not be explained through analysis of the individual elements. Emergence research distinguishes between weak and strong emergence. While weak emergence emanates from a provisional non-explainability of the rules, strong emergence means that the explanation gap is of a principal nature. However, in practise the epistemic gap between macro phenomena and elementary operations is often so great that the distinction between weak and strong emergence is simply irrelevant. Emergence is generally understood as a property of systems, so it is concerned with the structure of the world and is therefore an ontological term. As such, the question of how far the concept leads to an epistemological or phenomenological interpretation remains. The emergence concept, as I would like to use it, should in any case include the senses, body, qualia, and phenomenological human-technology relations. From a post-phenomenological perspective (third area: connections to the outside world), characteristics do not emerge within a system and appear as phenomena of a higher level, but rather between linked systems. Bearing in mind the associated difficulties, the – at least provisional – core of the magic of computation can form an emergence concept that is generally understood and simultaneously adapted to the situation of digital computers and their programming. However, referencing back to the emergence concept, shaped by science, always implies a demand to understand and reasonably justify the principles behind phenomena. If one wishes, on the other hand, as sketched out in the next section, to generate new sensory phenomena and perception offers and stage them, "magic" seems better suited as an adjective. Magic in the sense of the above characterisation, as an intervention on an objective basis that accepts how the world is made up and integrates itself in this structure. Whereby the scope of possibility of that which can happen is itself created beforehand. However, what shows itself is not forced but rather found.

The Kairos paradigm: Programming in art and design

> *'The ethical imperative: Act always so as to increase the number of choices.' And, 'The aesthetical imperative: If you desire to see, learn how to act.'*[27]

In a technology oriented towards progress, the development of software is also completely subject to the rational paradigm. It is about the production of planned functionalities and properties, economic considerations of efficiency and market potential and not least reliability and security. The latter includes the obligation to understand how programmes work and their effects, and predict which dangers they open up. Software development as an engineering discipline cannot forgo these objectives, as uses are developed under rational and normative aspects. No one wants to board unreliable aircraft or use insecure online-banking. The behaviour of software must be predictable and secure for every conceivable situation. However, parallel to this, the de-rationalisation, aesthetisation and emotionalisation of software has long been expedited by design and marketing. This is not only evident in advertising for software products, such as computer games. The idea of the creative expression of the user is generally forefront in digital, social medias. According to Andreas Reckwitz, growing aesthetisation is one of the main characteristics of modern capitalist society.

> *In the context of digital culture – especially with the help of mobile devices like the smartphone – the late-modern subject is constantly surrounded by global streams of symbols and images that are on hand for functional but especially also aesthetic use. In this, the computer and Internet user is an activated subject: they create text and images themselves, for example in social media, and thus become cultural-aesthetic performers online. The possibilities of the computer simultaneously transforms creative and design work as well as cooperation between producers and consumers. Computer games and digital photography contribute to the training of new forms of an aesthetic sense of play.*[28]

However, the attempt by "cultural-aesthetic performers" to create individual styles from media set pieces should not be confused with the creation and exploration of experimental spaces of experience suggested here. Consequently, the Kairos paradigm offers not only

27 Heinz von Foerster, *Understanding Understanding. Essays on Cybernetics and Cognition* (New York: Springer-Verlag, 2003), 303.
28 Andreas Reckwitz, *Kreativität und soziale Praxis. Studien zur Sozial- und Gesellschaftstheorie* (Bielefeld: transcript Verlag, 2016), 238.

a new experimental system for art and design, it is also to be understood as a call to take a critical position on the current aesthetic practices of the digital; for example, the use of creative artificial intelligence apps in social media.

Chronos and Kairos programming are two completely different modes of dealing with the unknown. Chronos programming desires understanding, security and predictability, so avoids everything unknown. Kairos programming, on the other hand, needs the unknown, it creates open spaces of action and searches for surprise and aesthetic experience within them. We wish finally, by way of a few examples, to at least suggest how the Kairos paradigm can build on the deterministic layers of the computers made available by the Chronos paradigm to generate the openness required. While Gumbrecht, as described above, sees the exploding possibilities via digital technologies in broad modernity as overwhelming, they are prerequisite for aesthetic action in the Kairos paradigm. Key to this are digital spaces of possibility.

"The Library of Babel"[29] is a story by Argentinian author Jorge Luis Borges from 1941. In it he describes a universe of hexagonal galleries which serve solely the storage and research of books. The infinite library seems to contain all possible combinations of books of a certain size (410 pages, 80 letters per line, 40 lines per page). Borges explains how the librarians explore this world of books and try to find sense in them. Even the discovery of singular coherent sentences within the text would already require a great deal of luck. Our universe ($\approx 10^{80}$ atoms) is too small to materially realise the $25^{1,320,000}$ books in the library of Babel. In order to create a book of 410 pages, 80 letters per line, 40 lines per page as a digital object, one can use a data structure of 1,320,000 symbols of the type "character." Once the data structure is laid out, the algorithm to generate the whole library, book for book, is made up of just a few lines of programme. Every single book can also be addressed and completely read. If one intends to write a book of 410 pages, there are two possibilities. In the Chronos paradigm you write the book yourself and thus keep control over every single word. In the Kairos paradigm, you only have to find the book, which already has its location (address) in the

29 Jorge Luis Borges, "La Biblioteca de Babel," in El jardín de senderos que se bifurcan (Buenos Aires: Editorial Sur, 1941) and Ficciones (Buenos Aires: Editorial Sur, 1944).

digital version of the library of Babel. If the books are arrayed completely at random, the chances of finding the book that one would have liked to have written are very slight. Therefore, the art is to construct the scope of possibility in such a way that all books that could be interesting from a certain perspective are close to each other or form their own subspaces in which uninteresting books are not even represented. On the other hand, of course, movement through the library could also be organised algorithmically in such a way that the probability of finding the right book on your travels is very high. The Kairos paradigm only comes into its own if I make a surprising discovery in line with the serendipity principle, namely if I find something that I was not even looking for through a happy coincidence.

Not only the space of possibility of texts, but also that of digital images is easy to describe on a software level. An image here is a simple two-dimensional field of pixels, each of which in turn is made up of three values for the three colour channels. Equally, the spaces of possibility of sounds or movements in space can be very simply realised in higher programming language. It is in the nature of the digital that whenever one lays out data structures (for image, text, sound, etc.) as variables, the whole scope of possibility of this data structure is also thus defined. As the example of the library of Babel shows, even relatively small data structures have such huge scopes of possibility that it is simply impossible to have all instances, that is the specific realisations of data objects, generated and shown. If we look at programming from this perspective, then algorithms are strategies for creating spaces of possibility and navigating in them. Uninteresting instances can either be already excluded at the construction of these spaces or avoided in the navigation through them. Artificial neuronal networks are also so successful because it is possible to automatically generate very efficient representations for text (text encoders) and images (image encoders) with the help of learning methods. So-called “latent spaces” are spaces of features or embedding, in which multitudes of objects are depicted in mathematic diversity in such a way that objects that are similar are close to one another. Latent spaces are, as a rule, adjusted by machine learning, whereby their interpretation is very difficult due to the explanation gaps of the algorithm described above. For example, the

learning methods to represent words in a text by high-dimensional vectors of real numbers are also called "word embeddings." Here the encoders and decoders realise the semantic connections to the outside world. As the digital representations for both text as well as for pictures are high-dimensional, real-value vector spaces, images and texts can then be relatively easily – for example, via spacing – placed in relation to one another. From the various modules for various purposes (for example, automatised image complementation, up-scaling, down-scaling, text-to-image and image-to-text), new experimental media spaces can be realised through alternating and iterated connection of these modules. Such configurations of artificial neuronal networks are simultaneously digital representatives of the broad present in line with Gumbrecht. Experimental media spaces are produced based on the whole spectrum of cultural products, at least as far as these are digitalised. In these spaces of possibility there is no longer a time arrow or linear order, the whole of the past is represented simultaneously. All aesthetics and all styles are present simultaneously and the challenge is to link these experimental spaces back to the users and their world. That means not only making them sensually and physically experienceable, but giving them sense in the first place and interpreting them subjectively and socially.

Artificial neuronal networks are currently the most interesting algorithmic representatives of the Kairos paradigm, although the Chronos paradigm tries to win back complete control over the networks through methods of "explainable AI" (XAI). Parallel to this, developing the Kairos paradigm means concentrating on the production of further embedding spaces and not on the recovery of control. My brief outline of the Kairos paradigm is probably unsatisfactory for both non-programmers and programmers. For the latter, code examples would be the most precise explanation. As the reader who seeks out this text is more likely to not be able to program, I have chosen the prose form, even if this means losing the precision that is actually necessary.

Authors' biographies in alphabetical order

Tobias Bieseke *is a research assistant at the Dortmund University of Applied Sciences and Arts in the storyLab kiU at the Dortmunder U (Center for Art and Creativity) and researches the potential of extended perceptions and narration for contemporary art. He experiments within the framework of artistic research and wanders on the threshold between artistic application and scientific investigation of new media. Since 2018, he has been undertaking his doctorate at the Academy of Media Arts (KHM) in the field of experimental computer science under Georg Trogemann. In 2023, he was able to make the success of his research visible for the first time, when he and Thomas Krupa won the German theater award "Der Faust" in the category of Genrespringer for the VR theaterproject "the wall 360°."*

Christian Heck *has been a academic-artistic staff for aesthetic and new technologies/experimental informatics, lecturer and doctoral researcher at the Academy of Media Arts Cologne (KHM) since 2017. His research and work focuses on peace research, aesthetic practice and AI critics. He is a member of the Forum Computer Professionals for Peace and Societal Responsibility (FIfF) e. V. and the German Informatics Society (GI).*

Mattis Kuhn *works on the reciprocal becoming of humans, machines and the shared environment. The focus is on text-based machines (as he describes currently himself as a text-based person) like algorithms, artificial intelligence, formal systems, software, and the intertwining of humanities, engineering and aesthetics. Essential aspects are non-/identity, decentralization and diversity, human-machine-environment entanglements, language and AI. He studied art at University of Art and Design Offenbach and Experimental Informatics at University for Media Art Cologne. He is currently artistic associate for Coding at Bauhaus-University Weimar and part of the ground zero research group at KHM Cologne.*

Steffen Mitschelen *is a design researcher and interface designer from Stuttgart, Germany, currently working as a UX designer and creative technologist at SAP. He holds a master's degree from the Merz Akademie, Stuttgart. As part of his PhD research at the KHM Cologne titled "Meta-tools," he conducts a series of workshops at various design schools, exploring the influence of design tools on the design work and designers' problem-solving capabilities. His work aims to provide a reflective basis for the understanding and conception of design tools.*

Zahra Mohammadganjee, *a Ph.D. candidate in Design Research at the Academy of Media Arts Cologne (KHM), also possesses a master's degree in product design from Sapienza University of Rome. Her passion lies in the characteristics of design knowledge, design process and design pedagogy. In her doctoral thesis, Zahra investigates the changing role of designers in the history of design, especially in two pioneering design educational approaches, D-school and Bauhaus, where she dissects the designer's field of action, tasks, and the definition of design knowledge in these two approaches.*

Christian Rust *is a PhD student at the Academy of Media Arts Cologne, where he conducts workshops in hands-on approaches to sound and obsolete media technologies. He holds degrees in musicology, philosophy, and computer science from Justus-Liebig-University Giessen. As a scholar in residence at the Deutsches Museum in Munich, he researched the bowed keyboard instruments in its collection. At the Greifenberg Institute of Organology, he explored historic techniques of instrument making through experimental archaeology and reverse engineering. He is currently developing an alternative interpretation of poiesis as a guest researcher at the Institute of Advanced Media Arts and Sciences in Ogaki.*

Somayyeh Shahhoseiny *is a design researcher holding a master's degree in product design from the Faculty of Architecture and Design of Sapienza University. She is currently pursuing a doctorate candidacy at the Academy of Media Arts in Cologne, and her work focuses on the human-space relationships through a phenomenological approach.*

Georg Trogemann *has been a Professor of Experimental Informatics at the Academy of Media Arts in Cologne since 1994. In 1977, he completed an apprenticeship as a carpenter. He studied computer science and mathematics at the University of Erlangen-Nuremberg, where he received his doctorate in 1990. From 1997 to 1999, and then later from 2004 to 2006, he was the pro-rector for research and infrastructure at the Academy of Media Arts in Cologne. His research topics include experimental algorithms, philosophy of technology, and the theory of artifacts. http://www.georgtrogemann.de*

Natalie Weinmann *is a Professor of Integrated Product Design at the University of Applied Sciences Coburg. Her ongoing research revolves around experimental design, fostering collaborations with colleagues in design, architecture, and natural science, bridging theory and practice. Her teaching philosophy underscores practical work and hands-on material experimentation, encouraging design students to nurture curiosity, adaptability, and a critical perspective on established norms. Simultaneously, she is actively pursuing her doctoral thesis at KHM Cologne, exploring how designers effectively navigate the unpredictable dimensions of the design process, drawing insights from her experiences in both higher education and practical settings.*