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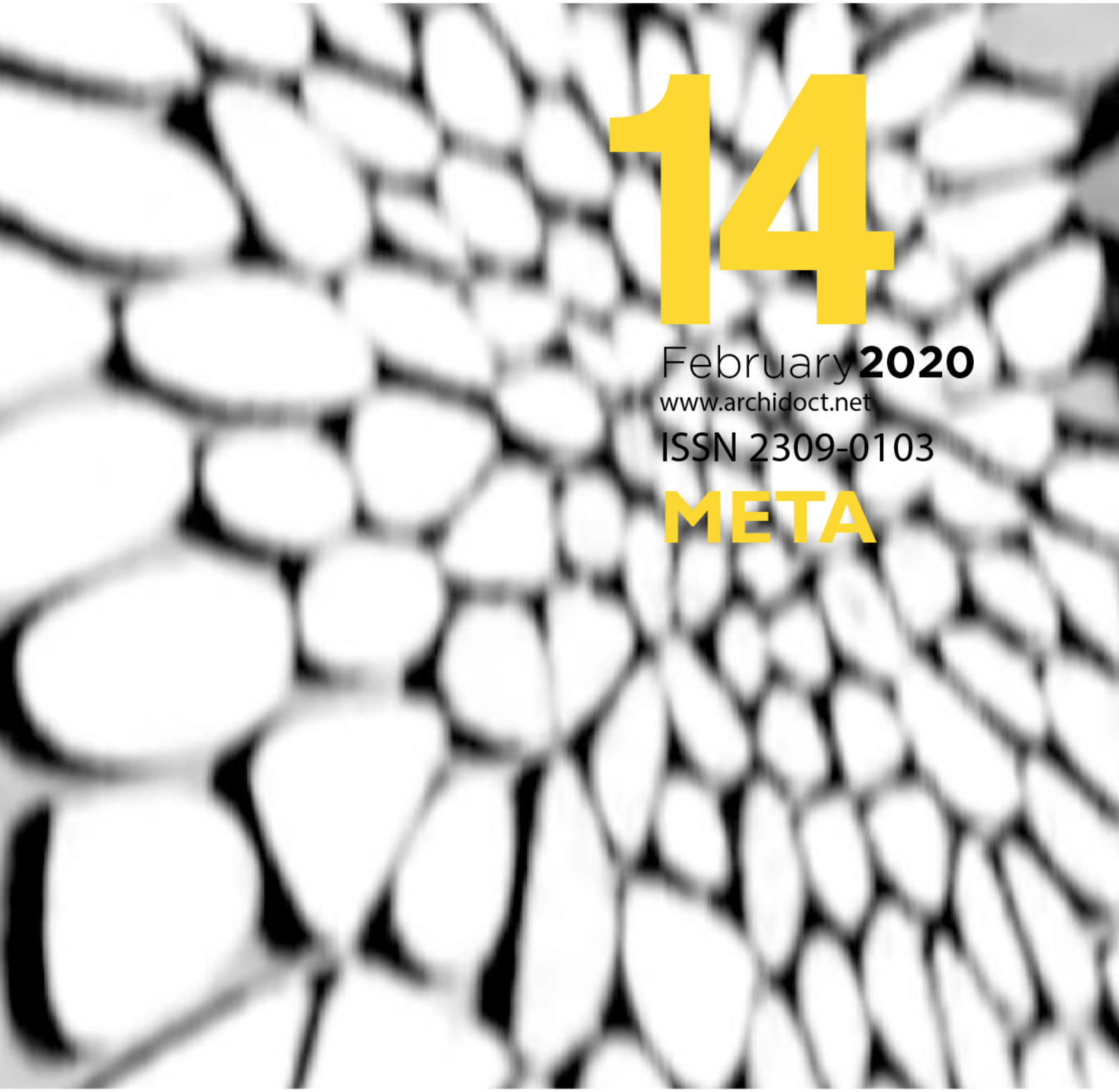

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Inbetween – A Post-Digital Turn – Craft-making 4.0

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Abstract

Traditional Western philosophy, cognitive science and traditional HCI frameworks approach the term digital and its implications with an implicit dualism (nature/culture, theory /practice, body/mind, human/machine). What lies between is a feature of our postmodern times, in which different states, conditions or positions merge and co-exist in a new, hybrid reality, a "continuous beta" (Mühlenbeck & Skibicki, 2007) version of becoming .

Post-digitality involves the physical dimensions of spatio-temporal engagements. This new ontological paradigm reconceptualizes digital technology through the experience of the human body and its senses, thus emphasizing form-taking, situational engagement and practice rather than symbolic, disembodied rationality. This raises two questions in particular: how to encourage curiosity, playfulness, serendipity, emergence, discourse and collectivity? How to construct working methods without foregrounding and dividing the subject into an individual that already takes position?

This paper briefly outlines the rhizomatic framework that I developed within my PhD research. This attempts to overcome two prevailing tendencies: first, the one-sided view of scientific approaches to knowledge acquisition and the purely application-oriented handling of materials, technologies and machines; second, the distanced perception of the world. In contrast, my work involves project-driven alchemic curiosity and doing research through artistic design practice. This means thinking through materials, technologies and machinic interactions. Now, at the end of this PhD journey, 10 interdisciplinary projects have emerged from this ontological queer-paradigm that is post-digital–crafting 4.0. Below I illustrate this approach and its outcomes.

Keywords
new materialism; alchemy, aesthesis; embodiment; interdisciplinarity; responsibility

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1 Introduction

Computer and web-based networks are integral to our digital, information-driven societies. Thus, technologies are interconnected to the conceptual models through which we understand the world (Busch & Palmås, 2006; De Landa, 1991; Deleuze, Guattari, & Massumi, 1987). History has witnessed epochal transformations of worldviews 1 as well as paradigm 2 shifts and industrial revolutions (so-called industry 3.0 and 4.0). Mechanization and later industrialization became decisive for how humans relate to each other, technology and nature (Marx, 1867). By nature, I mean how the material world was viewed epistemically and which active or passive character was attributed to non-living forms and forces. Post-industrial technology transformation and increasing dynamization have begun forming a hybrid reality and an intermediate, continuous state of transformation and becoming (Gilles Deleuze & Guattari, 2014). But our current, rather Biedermeier-like (Gordon & Mihailidis, 2016) approach to technology and digitality seems to shape our current alienation (Marx, 1932) from our existence (Dasein) (Heidegger, 1967), environment and fellow humans. In a social metabolic view, we again seem to be facing a turn of worldviews. We need to see the bigger picture of our own doing and acting and draw conclusions from our capitalistic consumerism. Some post-colonial, ontological and queering thoughts on digitality and handling of technologies attempt to illuminate this new emerging era, i.e., the post-digital turn (Crafting 4.0).

1.1 The anthropocene

Our present time, the so-called fourth industrial revolution (industry 4.0), is no longer phrasable, on either a cultural or an economic level, through a paradigmatic lens. Instead, the metaphor of social metabolism 3 is used to describe quantitative indicators of a metabolic turn of the Anthropocene (figure1). The Anthropocene captures a feature of human-made, artificial, technological interventions, actions and quantitative constructions over the last 100 years of high capitalism that impacts planet Earth on the level of the biosphere, lithosphere, hydrosphere, atmosphere and stratosphere.

In the age of craftsmanship, information, work and energy were coupled. In the digital age, machines take over work and design processes as well as control design and production information. Digital manufacturing seems to be increasingly eliminating both human, manual work in the production phase and the need for specialized manual skills. However, digital manufacturing techniques also offer opportunities, not least since they enable a new way of dealing with the topic of industrialization, mass production and individualization. Through so-called CAM (computer-aided manufacturing), technology and generative design enable us to produce copies from digital

1. Worldviews are constitutive manifestations of a particular view and determine how the world and its phenomena are interpreted. This applies not only to the interpretation of phenomena, but also to the selection of phenomena themselves. In this sense, the worldview defines what exists in the world and how we interpret and understand what exists (Wagner, 2011).

2. Paradigms are decisive for how we attribute active or passive character to materiality, how we perceive and recognize our material and technological world, based on which things in the world may only form meaningful and constitutive relationships between each other. Thus, our relationship with materiality and technology is always shaped by our understanding of the world. What I do not recognize neither exists for me nor can I understand it. Recognition — the recognizable — also concerns visibility, accessibility and experiencability. Experienceability implies experience and therefore perception.

3. The metaphor of metabolism is derived from the physical sciences. The notion of the social metabolism of the Anthropocene offers a framework for understanding how human technological and constructional actions cannot be conceived in isolation, but as interconnected transformations of the world (over the last hundred years, i.e. the high phase of technocratic capitalism) (Baccini & Brunner, 2012; González de Molina & Toledo, 2014)

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data providing consistent quality from the same source. This makes digital production perfect for new and evolutionary craftmanship, as well as for making minor or gradual adjustments to and iterative improvements between digital and analog processes. The production line is becoming an individualized permanent "beta" state. Never completed, it is constantly updated. Thus, digital design and manufacturing processes can follow the principles of open source. This movement enables sharing a design code and incorporating improvements from the outside through collective engagement, hence adding value. Information, craftsmanship and energy become perceptible and once again coupled. Mass customization is replaced by design on demand.

2 Main part

"InBetween," my title, is closely related to Greek "meta." This captures everything intermediate and brings into play a second, higher order of the present while connoting the past and the future. The InBetween seems to be characteristic of our postmodern, anthropocentric times, in which different states, conditions or positions exist side by side and coalesce into a hybrid, "continuous beta" (Mühlenbeck & Skibicki, 2007) and "becoming" (Deleuze & Guattari, 2014). Further, this InBetween describes a triad of intersecting lines of methods, tools and processes between material/machinic-, human- and digital/technological interactions (see figure 2), which can be entered like a prism from different sides and contexts.

My research blended performative processes and practices (resonance, affect and matter) with feminist queer and postcolonial theories that propose a new ontological queer-paradigm: the post-digital turn – Crafting 4.0. This paradigm comprises the physical dimensions of spatio-temporal engagement. It reconceptualizes digital technology through experiences of the human body and its senses, and thus emphasizes generative design as a form-giving process, engagement and practice rather than as symbolic, disembodied rationality. Within this rhizomatic research framework (fig. 3), which helped generate the proposed ontological queer- paradigm, I combined four associated theoretical concepts [4] with two practical concepts [5]. Together, these concepts move beyond dualistic assumptions and suggest a collective of human and open digital technologies, machines and nature, theory and practice. This configuration emerges from engaging, thinking and acting through the "middle" (par le milieu) (Deleuze et al., 1987, 293; Stengers, 2003, 187).

This post-colonial research framework enabled investigating performative processes and their potential for immediacy, co-emergence and integrative co-composition with digital technologies. Turning away from agency to relationships and processes, I sought to break

4. The four associated theoretical concepts stem from:

a. Post-cognitive sciences and the "enactive approach" (Gallagher, 2017); (Stephan, 2013); (Noë, 2004); (Varela, 1991); (Maturana & Varela, 1987a) Maturana, 1980) with adaptions from the field of interaction design with the concept of „embodied interaction"(Dourish, 2001).

b. Anthropology and "post-colonial aesthesis" (Mignolo & Vázquez, 2013);

c. Theories around feminist "new materialism" (Bennett, 2010; (Barad, 2007) (Randolph & Haraway, 1997) deriving from phenomenology and philosophy.

d. From phenomenological and philosophical "post-humanism" (Hayles, 1999), (Barad, 2003), (Stengers, 2010).

5. The theoretical concepts were combined with two practical concepts:

a. The alchemic concept of the „Wunderkammer" (Leibnitz, 1646–1716) at the time of the Renaissance. For the Baroque and the post-baroque Wunderkammer approach, which includes new media and technologies, see Anna Munster (2006).

b. The concept of research creation, as developed by the Senselab approach within the Canadian context and involving research network Immediations (Manning, 2014).

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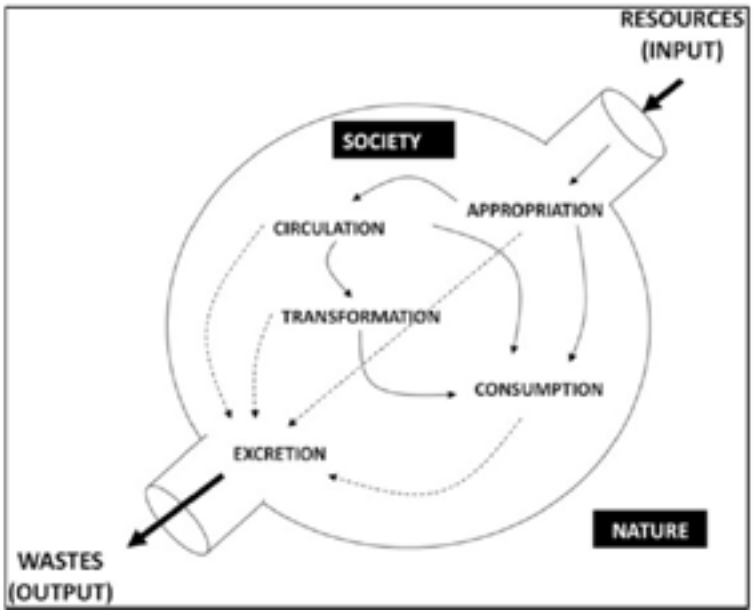

Figure 1.
Metabolism of the Anthropocene
Source Fig.1: rights @Ku Leuven https://www.arts.kuleuven.be/surplus/socialmetabolism (accessed 09.09.2019)

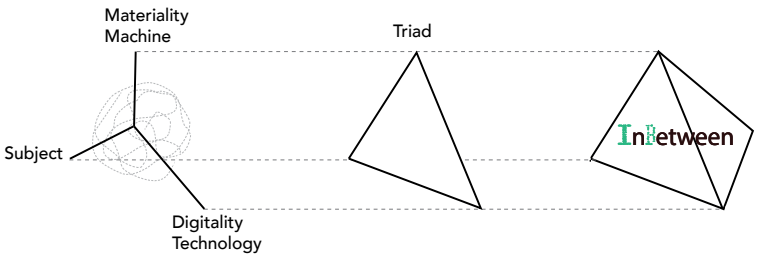

Figure 2.
Triad of InBetween: Intersecting lines of methods, tools and processes between material/machinic-, human- and digital/technological interactions
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Figure 3.
Ontological queer-paradigm: The post-digital research framework
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up the predominant "distribution of the sensible" (Rancière, 2006) by redistributing the sensible through a multiplicity of centres and different sources of intelligence as a hybrid, parasitic and collective engagement between digital technologies humans, and non-human knowledge.

3.1 Experience, embodiment and enactment

The classical mind-body problem (Cartesian dualism) determines the ontological status of mental properties in relation to physical properties. As Baudrillard (2008) observes: "Calculating and logical thought only serves to exploit the world while separating us from it" (Baudrillard, 2008; 10). This dualism erodes if we think of natural processes, organisms possessing collective intelligence, the swarm behaviour of animals and biomimicry principles. The original, biologically founded concept of emergent self-organization ("autopoiesis") (Maturana & Varela, 1987) drew on cell biology, highlighted the existence of resonant, unicellular organisms and thus substantiated new cognition theory [6] (figures.4, 5).

By shifting to a sensorimotor account (i.e., enactive cognition) [7] of consciousness, human perception (cognition) arises from a dynamic, physical interaction between living beings and their environment. The "enactive approach" (Varela, 1991) describes a sensorimotor approach to humans that includes physical and cognitive processes (embodied cognition) as well as the specific situation of cognition (embedded cognition). "Enactivism" describes a continuous, dynamic process of participatory, sensomotoric sense formation and mutual interaction, and the coordination of two embodied actants and their mutual causal relationship including the specific environment. Thus, knowledge arises from the interrelation and interdependence of psychological, biological, physical, social and cultural phenomena. It involves shared social reality and the organism as a situational, active (inclusive) and creative participant — rather than as a passive observer (Varela, 1991). Perception and consciousness, as well as the qualia thereby involved, are products originating from cognitive activity. Hence, they do not simply happen, but arise through an organism interacting with its environment (Noë, 2004). Perception and experience in this sense are an "enactive" (ibid) approach to tracing bodily-material effects and their affective force relations, in order to associate discrete elements in a sensible, embodied way as an interlaced assemblage of life (Deleuze, Guattari, 1980). The proposed "enactivst" concept of humans, non-humans and technology understands these entities as different organisms, as different sources of intelligence. This approach has the potential to shift our perspective beyond hierarchical, dominating, colonialized systems and comparisons. Once adopted, it enables us to move beyond human-centred design towards more complex, entangled and assemblage-like un-

6. "Thus, if a cell interacts with molecule X and incorporates it in its processes, what takes place as a result of this interaction is determined not by the properties of molecule X but by the way in which that molecule is "seen" or taken by the cell as it incorporates the molecule in its autopoietic dynamics. The changes that occur therein as a result of this interaction will be those changes caused by the cell's own structure as a unity. Therefore, inasmuch as the autopoietic organization causes biologic phenomenology by bringing about living beings as autonomous unities, a biologic phenomenon will be any phenomenon that involves the autopoiesis of at least one living being" (Maturana & Varela, 1987b; 51, 52).

7. This is the assumption of recent post-cognitive phenomenological approaches (Gallagher, 2017; Stephan, 2013; Noë, 2004; Varela, 1991; Maturana & Varela, 1987a) and of interaction design approaches (Dourish, 2001; Depraz, 2003).

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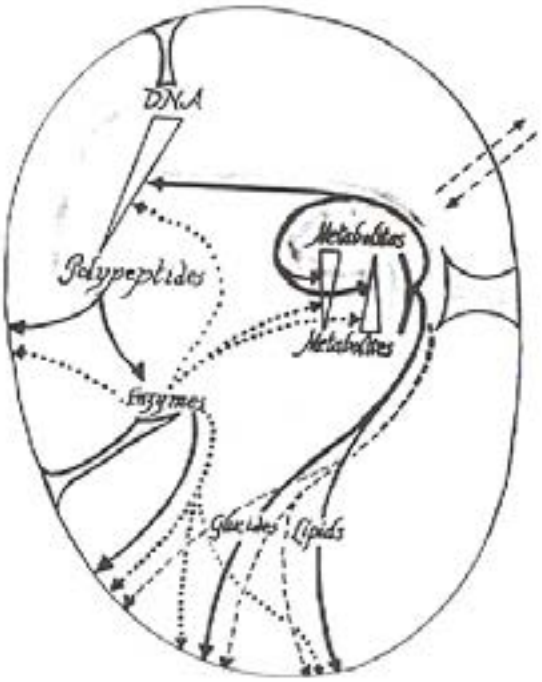

Figure 4.
"Representation of the autopoietic network" (Maturana, 1980, X)

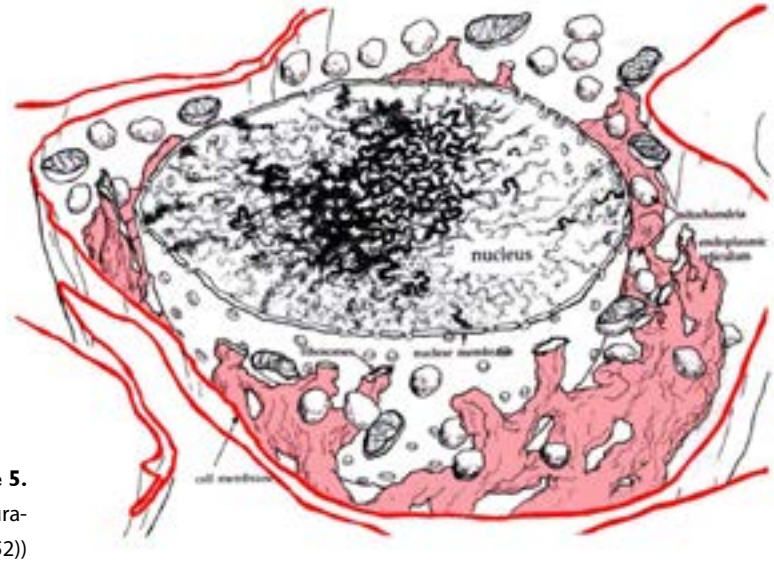

Figure 5.
"Diagram of the main profiles of the leech cell" (Maturana & Varela, 1987b, 52))

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derstandings of life and of our future coexistence with other kinds of materials and intelligences that blur the boundaries between humans, non-humans and technology.

3.2 The otherness

Today's manifold information and data streams, "the colonisation of everyday life by information processing," tend to become meaningless, to the point where we are losing ourselves and where manifoldness has begun creating an isolated perception of the world (Greenfield, 2017; 113). In this colonial, Biedermeierish view on technology, people focus on domestic, "panoptic" (Foucault, 1976) isolation. Consequently, representations and simulations of things come to replace those things themselfes and active engagement is reduced to clicking a "Like" button (Gordon & Mihailidis, 2016; 38). These constitutive effects of massed media and simulations have created a hyperreality. Therein, we only experience doctored realities such as edited war footage or reality TV, just as the distinction between the "real" and simulations has collapsed.

The concepts of "otherness" (Baudrillard, 1994) or becoming "otherwise other" (Guattari, 2010) discuss the aspect of the "other" — similar to how they describe nature, technology and digitality. The concept of "otherwise" (i.Bid.) or "otherness" (i.Bid.) overcomes the dualism of subject and object and thus enables the alterity of the non-human or supernatural to appear (Braidotti, 2019). Today's hyperreality is by no means a new phenomenon. In Ancient Greece, hybrids in form of supernatural creatures were the Gods of Olympus, an eminent example of how the familiar self and otherness were merged into a single complex being. These hybrids combined the savagery of nature with the intelligence of humans, making them powerful allies. Today, "otherness" (i.Bid.) has begun appearing in different forms of digital cyber cultures, avatars, cyborgs, the quantified self, artificial intelligence (AI), where the digital merges with the physical as a constituting effect of technological mediations.

The Renaissance glorified the human conquest and domination of the world. Ever since, human universality has occupied centre stage, as best displayed by paintings or artificial garden concepts (Kristeller, 1990; 108). In following Deleuze`s (2008) thinking, we might instead imagine a world without axes, yet with different sources of intelligence and a multiplicity of centres (Deleuze, 2008). By embracing complexity and the processes occurring between different sources of intelligence (organisms), this line of thought creates a void that allows for movement and establishes "an intermediate or transitional place or state" (Jardine, 1984; 46). Trusting in multiple mediating natures — "otherness" (i.Bid.) — brings forth different contextual galaxies, each with different flavours, moods, atmospheres or tempers. Objective navigation through data once again becomes possible and makes us digital literates, yet from a personal point of perspective.

3.3 New materialism

In the digital age, with materiality becoming superfluous, materials seem to have lost their relevance. "Dematerialized informatization" (Folkers, 2015; 7), i.e., the "ratio" process that ever since Descartes (1641) has placed the rational mind above sensual perception, the body and nature, alienates and abstracts modern humans from materiality. The current material turn, discussed in the heterogeneous discourse of new materialism, is aware of a new material sensitivity and is shifting the focus back to the meaningful role of materiality and the interactive relationships between technology, humans and non-humans, which together form a holistic experience of reality. Materials bring information into the social fold, where the constitutive, spatial quality of the

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material enables physically encountering or capturing information and interconnecting hybrid layers of reality. So-called "material agency" (Knappett & Malafouris, 2008; ix) plays its (essential) part in the creative, inclusive source of new formations of knowledge production — as "a multiple and collective affair," as a complex assemblage and equal entity (Braidotti, 2019; ix).

3.4 Affect and resonance and post-colonial aethetics

"Various ecologies" (Stengers 2005; 2010, 40) of discipline-specific practices have become part of affect and resonance. These have gradually erased discipline-oriented working methods and created collaborative (socially, spatially and materially embedded) participation and engagement. Affect, as Deleuze (1990) tells us in discussing Spinoza, is impersonal. While it is not bound to subjects, it nevertheless produces them. Pursuing this logic of affect, Massumi has underscored its autonomy in terms of subjective production, yet without being able to predetermine their becoming. To grasp affect, Deleuze and Massumi (2014), writing from within a Western and colonial context, gesture towards the aesthetic theories and practices of sensation. This, they claim, eludes the (colonial) subject while determining it. Likewise, Mignolo (Mignolo & Vázquez, 2013) contrasts the concept of aisthesis (i.e. the modes of perception) with that of aesthetics. The concept of affect and decolonial aisthesis endeavour to break up the predominant "division of the sensual" (Rancière, 2006). This, as V. Foerster (1985) has shown, is the political dimension of an aesthetic founded in the concept of perception. The principle of responsibility, which is determined by two imperatives. The post-colonial theory of aisthesis is seen as a way of thinking in order to overcome the gap in the discourse of pragmatics and aesthetics, structure and function (Von Foerster, 1985). This means switching the theory of perception from the static view to the dynamics of movements. The focus lies on how aesthesic design practices of "enactive"/interactive systems impact contemporary societal, cultural, economic, environmental, or political movement and social engagements.

3.5 Alchemic experimenting with digital and material processes

The symbiosis of additive manufacturing processes and performative material behaviour, whose interaction creates the final form, is called generative design. Generative design imitates nature's evolutionary approach to development and represents a post-humanist ideology, in which designers are no longer the "creators" of form. Nor do they determine how material is formed, or how it should behave and look. Instead, they become composers who, similar to the old alchemists, conduct analogue and digital experiments to see which phenomena emerge from, become recognizable and crystallize through this process. This generative relationship — between material arrangement and form behaviour —endeavours to work together with the environment. It seeks to use growth — arrangement and stiffening principles (bionics, biomimicry, mathematical principles) to develop a new language of form involving less material consumption, and thus to create a new design aesthetic of things. The proposed post-digital turn encourages a dialectic relationship between embodied interaction and digital, generative design. It suggests that the future of interaction lies not in the interface "disappearing," but in it becoming even more visible or available for a broader spectrum of engagements and interactions, interpersonal relationships, experiences and embodiments. "Thus the call for a more experimental attitude toward reality and the potential for self-organisation is inherent in even the humblest forms of matter-energy" (De Landa, 1997; 273).

Humans may assume the role of the other. Perspectives intertwine in the interaction between

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the ego and material and digital engagements. This, in turn, integrates individuals and their actions into a general process of experience and behaviour. Generative design can take a new step further into real-world engagement, by profiling, modifying and adapting designs to the lived milieu. It does so, among others, by inventing a new, internal structure and by completely inserting itself in a given situation - "solid and tangible in their particularity" (Barad, 2012; 80).

4 One example of project outcomes and resume

Based on the elaborated rhizomatic methodological framework, I have developed 10 interdisciplinary projects over the last three years and subsequently various interdisciplinary working methods in four different areas (figure 7): 1. research and development; 2. workshop format for experts and laypersons; 3. teaching format; 4. business concept.

Below is an example of how I adapted the rhizomatic research framework to different projects (fig. 8). I sketch one project and its manifold material, digital, technological and machinic interactions.

4.1 Project example "Parametric Sewing patterns"

The emerging field of computational fabrication is making new ways of designing and manufacturing supported by generative design (parametric design) more and more accessible. These new manufacturing methods also allow exploring different algorithms, their differences and the generated results in physical space. The role of designers is therefore shifting. Today, designers need to embrace complexity and processes between different sources of intelligence (algorithms, material behaviour, aesthetics, sewing machine conditions). As a result, they adapt objective initializations of parameters from their own perspective and reiterate these in a symbiotic process between virtual modelling and real-world cutting.

Cut-to-fit software, while state-of-the-art, has limitations as it is based on norms and rules dating from early sewing pattern developments (Butterick, 1871). The human body is not standardizable and has different shapes and aesthetic needs. Hence, surface cutting and parameterization through algorithmic parametrization enable handling doubly curved surfaces (the body) with low distortion on 2D (paper or fabric).

Starting from scratch, i.e. ignoring assumptions about the historical art and rules of sewing patterns, this project starts from an experimental body-centred approach to create individual sewing patterns using off-standard intersection lines. Instead of trying to adapt the body to standardized norms, this project explores the beauty of imperfection, quirks and identity.

This project evolved from collaboration between a mathematician, computer scientist and myself – an architect and textile designer. Using an architectural and mathematical approach to algorithmic, generative 3D modelling and mathematical segmentation, we placed section lines individually on each specific 3D body surface scan, to best subdivide the garment undistorted. Applying this innovative methodology means that the pattern designs are at first virtual spatial and mathematical surface simulations. These, however, need to be tested, adapted and reiterated in a symbiotic process between virtual modelling and real-world cutting, sewing and fitting that also transforms the virtual fashion outcomes as an interactive ecology.

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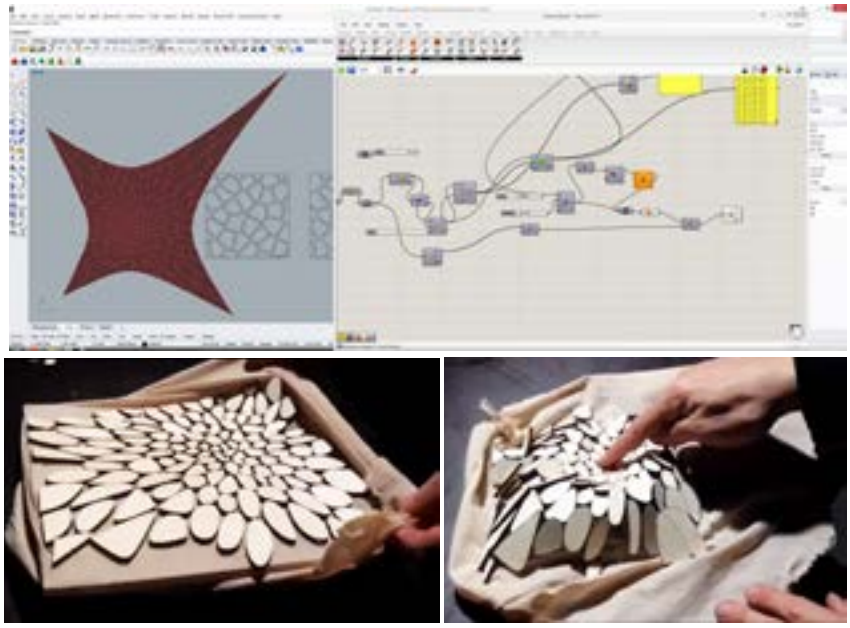

Figure 6.
Digital and material interaction, prototyping
Verena Ziegler (2017)
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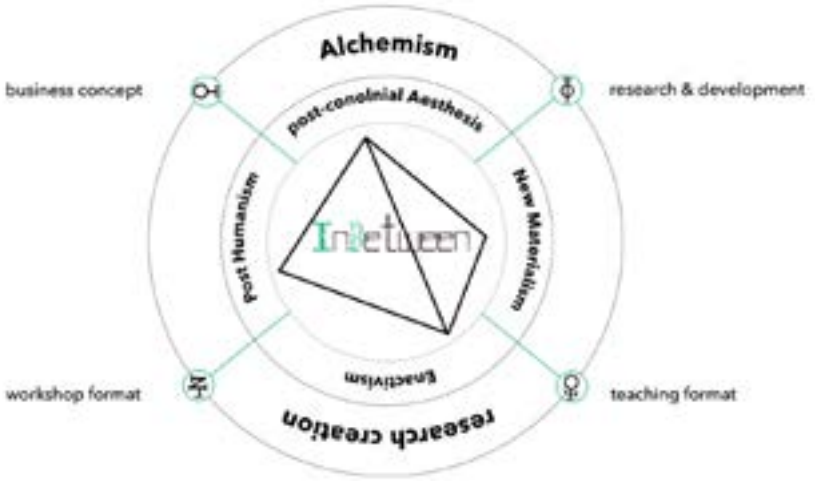

Figure 7.
Development of interdisciplinary working methods for four areas
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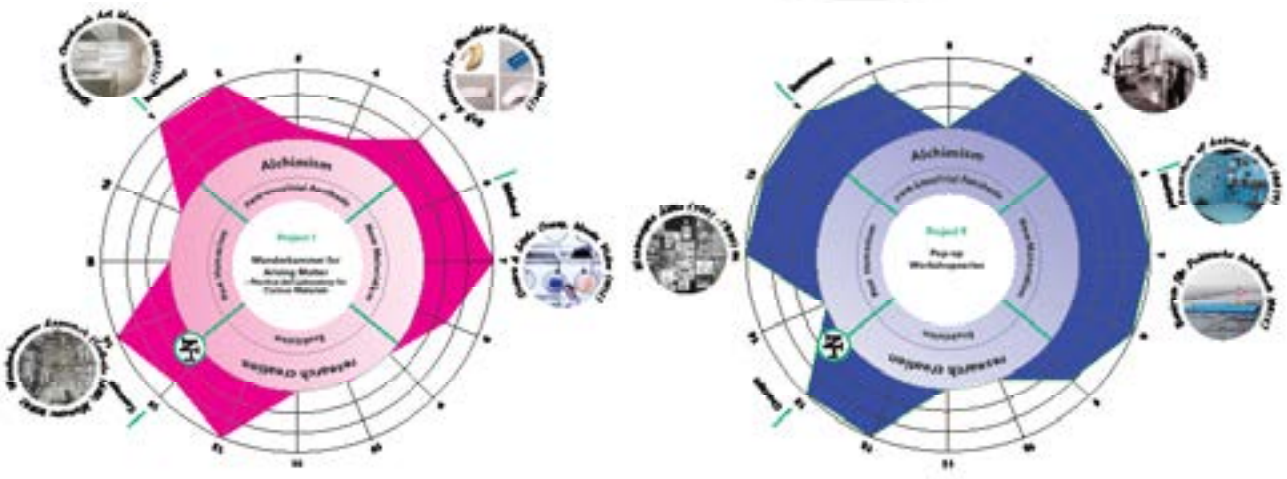

Figure 8.
Rhizomatic research framework adapted to different projects (2019), here two workshop formats, left side developed for experts, right side developed for layperson
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Many applications of avatar models (in cinema, gaming or VR art) focus on perfect, graphic appearance and performance of avatars, which are rather idealized and can be created virtually. It is already possible to realistically represent virtually designed fashion and clothing items on a virtual model. Garment production methods, however, are based on analogous, conventional pattern creating approaches and methods. The established methods for the virtual development and segmentation of 3D-surfaces are based on visual realism. Thus, they are not realistic models in any physiological sense, but based on a representative visual level in a synthesized virtual scenario. The models are as such not based on real surfaces, but on virtually generated surfaces. Our approach comprises a virtual processing and segmentation method for modelling real, material and physical bodies (3D scan body data) by creating intersection lines for sewing patterns using virtual body topology. This body-centred method of producing sewing patterns makes no assumptions about analogue, conventional pattern creating approaches and methods. In contrast, our method highlights the transferability of virtual pattern development into reality.

Virtual processing of 3D surfaces, generated from human body scan data via a mobile app, will be used to create body-generated clothing. The result is a completely new pattern design technique and pattern design aesthetic. This considers the individual human body and enables creating fitting personalized clothes without distortions, pull lines and gapping. We achieve this by sewing experimentally through prototyping and by iteratively rethinking the manufacturing process. Think local, act global: our technique will support and transform local craftsmanship into a new era of digital craftsmanship 4.0. Our interdisciplinary, iterative and practice-based investigation spanning computer science, architecture, textile design and mathematics, algorithmic thinking and practical exploitation of pattern-form formation, we developed a sustainable approach to reducing waste consumption, among others, by striving to counteract the standardization of S to XL, by excluding disabilities and size-zero ideology (inclusive design) and by genderfying norms and rules.

By way of a brief outlook to a possible future scenario: This algorithmic approach to sewing patterns might not merely entail a symbiotic process between virtual modelling and real-world cutting. It might also involve other sets of data (e.g., digital avatar profiles of phantasy characters, heroes, or utopies, as illustrated by Björk`s recent album Vulnicura and her otherworldly virtual avatar). Thus, in our present context, this alternative conceptualization might contribute to generating an innovative physical approach to pattern creation.

4.2 Summary

This paper has outlined my rhizomatic research framework and highlighted two aspects. First, our "panoptic" (Foucault, 1976) Biedermeier approach to technology has led to (3rd person) abstraction, generalisation and a loss of resonance with the world. Second, the specific demands of capitalism, in particular its acceleration of optimization and consumerism, have created an aggressive human-world relationship, and thus the loss of resonance and meaning. In conclusion, we need a radical shift in thinking, in order to transcend determinism. Prevailing assembly-line thinking and action, as a historically derived, colonial conquest, does not seem well suited to attaining a sustainable future. I have instead argued for an ontological queer-paradigm, which I call the post-digital turn or Crafting 4.0.

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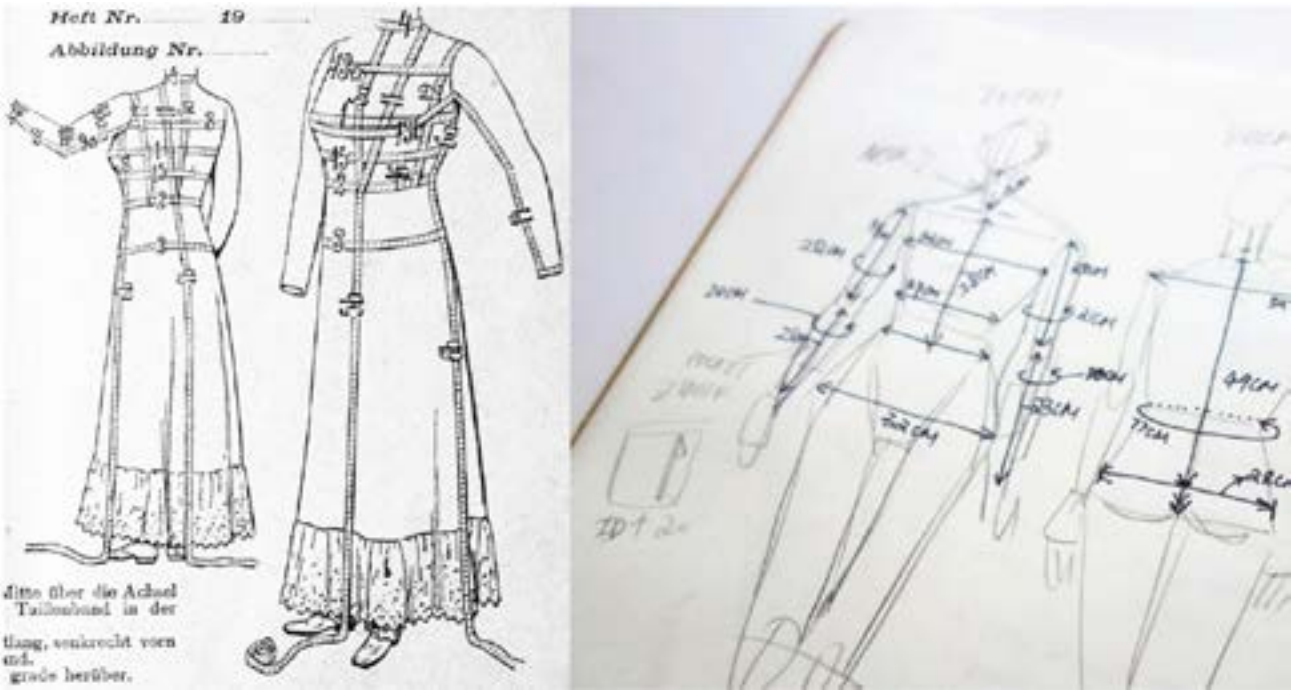

Figure 9.
Original sewing pattern approach after E. Butterick (1871), sketch Verena Ziegler
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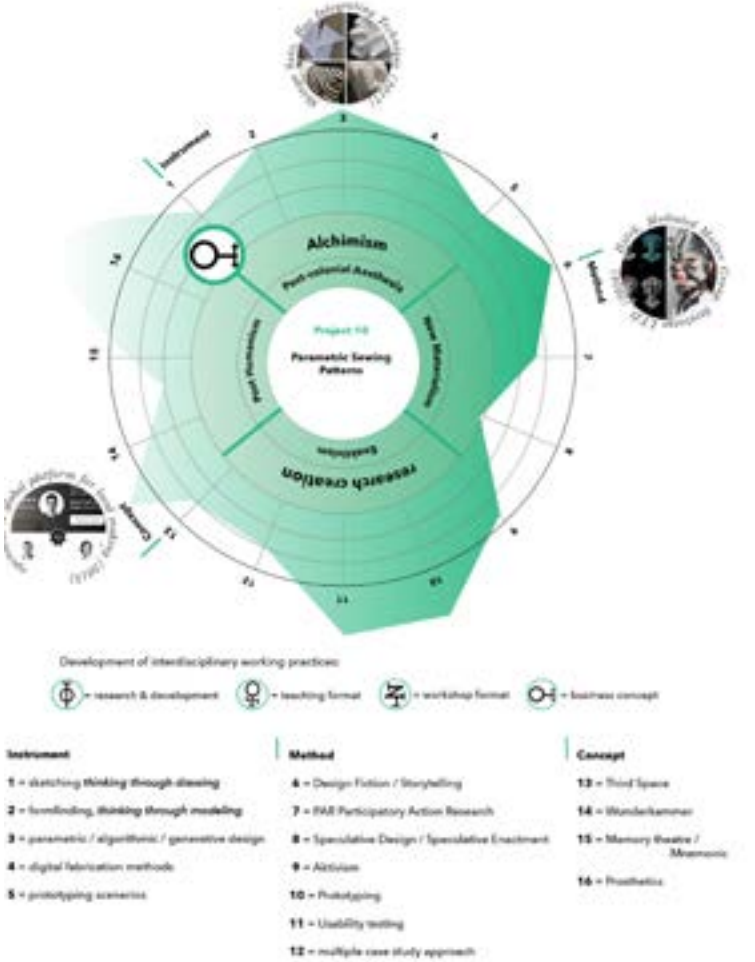

Figure 10.
Rhizomatic research framework adapted to project:
"Parametric Sewing Patterns"
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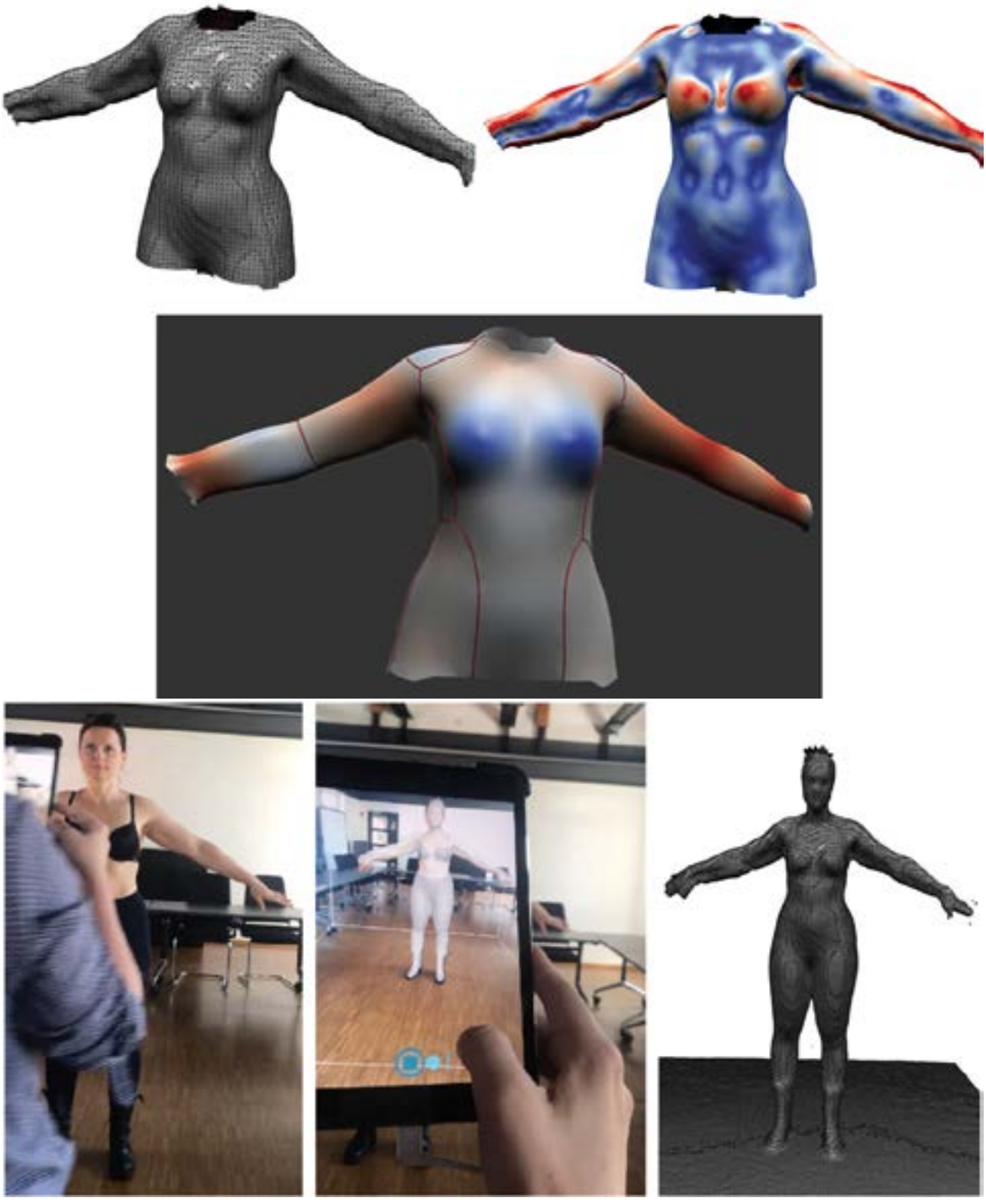

Figure 11.
: Process from 3D body scan to virtual body topology and tension segmentation
Source Fig.11 , rights @Verena Ziegler, Dr. Frauke Link, Nico Bruegel (2019)

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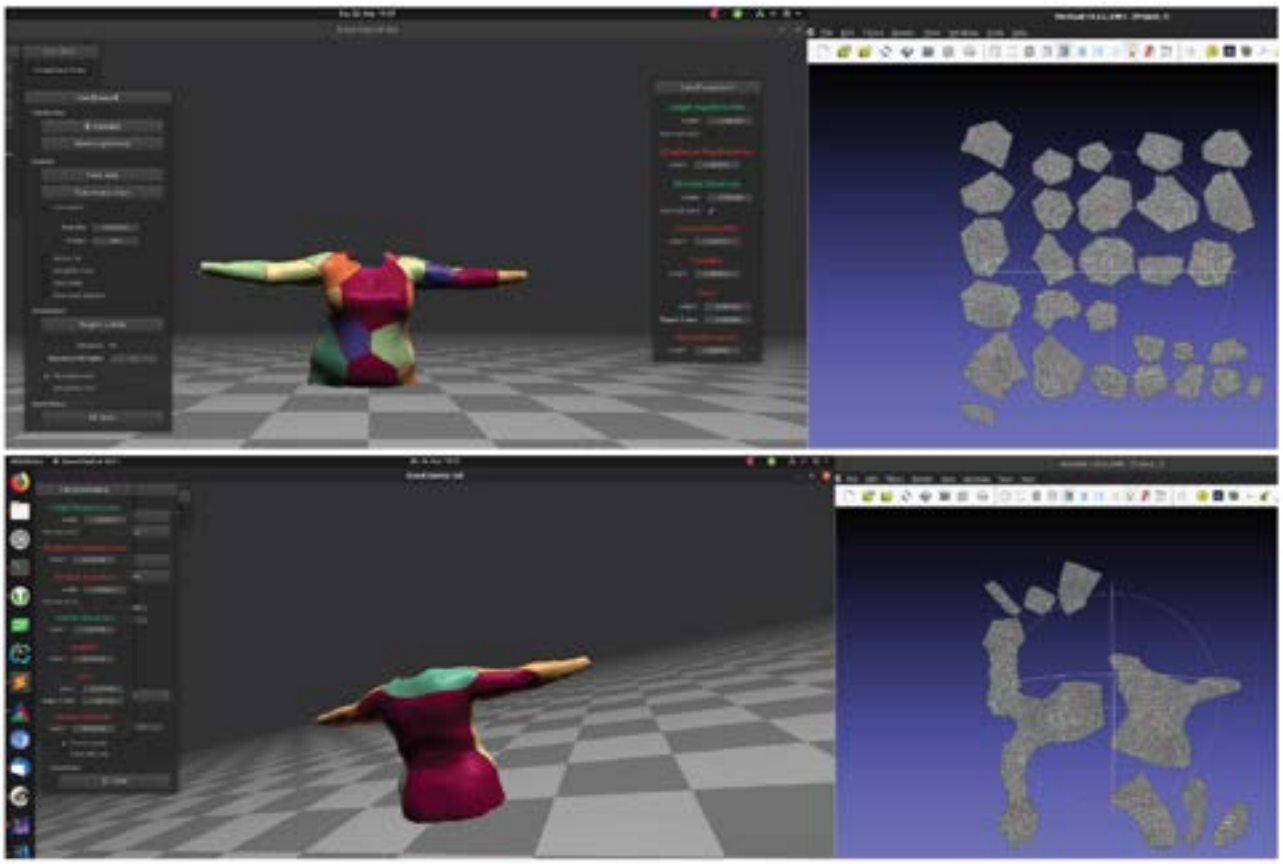

Figure 12.
Parametric, algorithmic segmentation process
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Figure 13.
Prototyping the experimental sewing patterns
Source Fig.13 , rights @Verena Ziegler, Dr. Frauke Link

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