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SPECULATING ON DESIGN, LIFE STYLES AND FORMS

Studies in the Contexts of Climate Change and Sustainability

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Abstract

This thesis explores a speculative, nondualist and relational design approach to engaging with ongoing climate change and sustainable design transformations. Posthumanism, amongst other theories, has attempted to use nondualist views and relational thinking to reconfigure nonbinary futures and deal with the challenges of the Anthropocene, which was formulated to address human activities with unsustainable consequences for survivable futures. Designers and design researchers have adopted future-oriented perspectives on and approaches to ecological crises. Such speculative design inquiry challenges the earlier techno-determinist and extractivist economic models to which design has contributed by problematising and shaping our understanding of the complexity of climate change from sociotechnical and cultural perspectives. However, future-oriented design theories largely lack relational conceptualisations and practices of sustainability. If we seek a fundamental change in design towards long-term sustainability, we must address nondualism and relational thinking in design theory and practice.

This thesis argues for an Eco-Cultural-Techno Design Speculative Approach to understanding the problems and potentials of long-term sustainable transformations. It presents a practice-based design speculative inquiry and related processes for designing Eco-Cultural-Techno futures. The research considers posthumanist notions and practices of Life Forms and Life Styles, encompassing nonbinary, nondualist, non-anthropocentric views and relational thinking. Based on this emergent viewpoint on posthumanism, Life Forms and Life Styles, the research consists of two heuristic and speculative design studies that offer critiques of the field of cosmetics and consumer culture through two projects, LO and XIANGVEI, that explore alternative conceptualisations and new relationships of design-based Eco-Cultural-Techno futures. Structurally, the study takes the format of an article-based thesis bound together by an exegesis.

The thesis offers three overarching contributions to design research. The first is a conceptual approach based on design-centred, posthumanist notions of Life Forms and Life Styles to investigate Eco-Cultural-Techno futures for transitioning to long-term sustainability. It also offers a Speculative Life-Style-Form Design Perspective through which this Approach may be read in greater depth. Second, the thesis demonstrates the design-inflected possibilities of multisensory and cooperative futures that could contribute to rethinking and supporting long-term sustainability. Third, the inquiry indicates that practice-based investigations through speculative design may highlight and elevate the potential to facilitate plural spaces for sustainable transitions. The thesis closes with a discussion of the possible directions for future research, including making connections between imagination, climate change and design and the means of implementing these ideas in design research, education, culture and policy.

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Yue Zou, 2 August 2022, Shanghai, China

Contents

1. Introduction

1.1 Urgent Times, Changing Climates

As designers, we make artefacts to improve our ability to transform the world for better living and enrich daily cultural life. By contrast, artefacts' uses of natural resources and related consumerism have been deeply damaging to nonhumans and the planet. As a result, design is complicit in the generation of climate change, the Anthropocene and other ecological crises (Bratton, 2019). Climate change – the erosion of our living environments and biodiversity loss, amongst other issues framed by the contested concept of the Anthropocene (Folke et al., 2021) – demands that we rethink our modes and models of 'development' and notions and design practices of quality life and sustainability.

What does a temperature increase of 1.5 degrees Celsius, within which the world needs to remain to avert unstoppable climate disaster, mean to us? In our daily lives, it is challenging to realise the meaning of this number for the survival of human beings, let alone the planet (Intergovernmental Panel on Climate Change [IPCC], 2018, 2022). Still, it is clear that we have not fully respected other entities in ecological systems or acknowledged environmental degradation until they have become deeply challenging to human and nonhuman survival.

> 天地与我并生，万物与我为一
> 庄子
>
> Heaven, Earth and I come into being together, and all things and I are one.
> Zhuang Zhou (369–286 BC)

As humans, we are part of biological ecology. This view of the relationship between nonhumans and humans, which has recently been discussed in posthumanism as key to solving human crises (e.g., Ferrando, 2019; Haraway, 2016; Morton, 2018), appeared in China more than two thousand years ago.

Design has worked with sustainability to address environmental crises for decades, but it is only more recently that models of underlying economic growth have been demonstrated as requiring change in elaborations of approaches to design for sustainability (DfS) (Ceschin and Gaziulusoy, 2016). Design approaches have also begun to pay attention to reinventing the relationship between humans and nonhumans from a posthumanist perspective to address ecological crises, although they are only rarely articulated in scholarly articles (e.g., Forlano, 2017). These approaches have asked us to imagine how we will live, consume and experience life with a sustainable future in mind.

We are always eager to imagine a better life in the future, which is why many consumer brands champion the future, producing installations that generate high-tech scenarios to show what quality of life can be. For example, at SKP-S in Beijing, the shopping mall with the highest global sales worldwide, fantasy installations show future scenarios of different aspects of everyday life from farming to cosmetics[1]. The products in the installations are not related to the products currently on sale in the mall; rather, they promote more consumption through a fantastic and pleasurable experience. Beyond this future-related installation, design artefacts of futures in academic research can be used as a way of knowing, of thinking with artefacts and of raising questions in the fields of critical design and speculative design (Auger, 2013; Dunne and Raby, 2013; Malpass, 2017). These fields offer us approaches to re-imagine models and worldviews centred on 'progress' and the consequences of our policies and actions as consumers to create an atmosphere for sustainable transitions. They have also inspired design research to explore new approaches to address climate change by examining sustainable futures.

In considering complex futures, the present study adopts a dynamic approach between learning and speculative making to connect transdisciplinary knowledge from different research streams through design and to build up a relational framework to analyse and understand the complexity and difficulties of consumerism, technological development and climate change.

1.2 Exploring Design Approaches in the Context of Climate Change

The combination of the ecological crisis, consumerist culture and technology-driven solutions may be viewed as a problem without a solution (Jongerius and Schouwenberg, 2018). They are clearly complex matters requiring design to confront deep challenges and change its key practices. In response, we might follow Donna Haraway's posthumanist advice and consider how to 'stay with the trouble' (2016, p. 2) so that we approach design more as a matter of problem framing and a prompt towards change.

Posthumanism focuses on the transformation from humanism to a nondualist human view[2] and considers how to evade and eliminate the various predicaments of technology, politics, society, culture and ecology related to humanism (Ferrando, 2013, 2019; Wolfe, 2009). As part of making sense and meaning in the contexts of crisis and change, engaging with the speculative to act experimentally towards our troubles (Connolly, 2013) offers one means to support cognition and knowledge. Transformation is discussed in the design world concerning sustainable

1 The introduction of installations at the SKP-S mall can be found at https://superfuture.com/2020/01/new-shops/beijing-skp-s-mall-opening/.

2 The current ecological, technological, social and cultural issues that we face ask for nondualist and non-anthropocentric thinking, which are the core of posthumanism and may be beyond the scope of our cognition and knowledge (Ranisch and Sorgner, 2014a).

futures[3]. Further, design and artistic approaches connected to media ecologies challenge the dualism of the Anthropocene, ontologically and epistemologically, and position nonbinary relations between human and nonhuman, between nature and between other binaries (Witzgall, 2021a). We are in an era of challenge, change and contestation, as 2022's headlines regarding the climate, a persistent global pandemic and war make clear. Each of these is an enormously difficult issue. Collectively, they challenge us to reconsider the alternatives that will shape our shared futures.

I draw on speculative design to discuss and analyse these transformations towards alternative futures through cosmetics in design research terms. Compared with contemporary commercial design, speculative design uses design artefacts to ask questions and provide a place for discussion, exploring alternative ways of being and encouraging imagination (Auger, 2013; Dunne and Raby, 2013). It offers a new approach to contemporary design, which has shown itself to be incapable of dealing fully with consumerism, climate change and other ecological crises that present as wicked problems, which are difficult to define and thus need to be fleshed out through their solutions (Conklin, 2006; Rittel and Webber, 1973). Speculative design uses design artefacts to poetically question and reposition (Ávila, 2012, 2021) existing practices and paradigms and gain further insights to engage directly in current development (Auger, 2013). Speculative design addresses design's role of knowing and thinking, such as the elaboration of Dunne and Raby's A/B Manifesto[4], which holds that design will move the focus from solving problems to finding problems. I elaborate more roles of speculative design in Chapter 2 to show the potential of design to transform not only commercial practice but also society as a whole.

Speculative design also challenges industrial design from a critical stance and suggests a potential cultural role for industrial design. Speculative artefacts can be used to project social-technical trends in everyday life (Malpass, 2017). Research in speculative design has the potential to question the current situation of ecological crisis and provide alternative futures to direct our sustainable development by making different products (Edeholt, Joseph and Xia, 2021) in which we embed and embody values, propositions and concepts. We do this to materialise possible alternative futures to reframe problems (Wilkie, 2018).

Speculative design has helped me to rethink my first internship experience at designaffairs, a global design studio, 10 years ago. My task was to find some future trends for Audi products, which involved collecting as much lifestyle and technology news as possible, conducting interviews with experts and users, filtering the information based on the content of

3 Consider, for example, the concept of transition design, which seeks to transform the social-technical system to build a sustainable world (Irwin, 2015).

4 A/B Manifesto: http://dunneandraby.co.uk/content/projects/476/.

those interviews and making strategic design cases. This was a linear design process for sales promotion based on the past. As we now face the uncertainty caused by ecological crisis and seemingly endless overconsumption, future design practice is not just an academic trend but a practice beyond human-centred insight to discover and explore problems that will create more possibilities and develop alternative solutions by using design to confront the wicked problem of climate change (Nelson and Stolterman, 2012).

As outlined further in Chapter 2, design has taken up different approaches to explore the future through imagination and speculation (Auger, 2013; Hales, 2013; Kuzmanovic and Gaffney, 2017; Tharp and Tharp, 2019; Wilkie, 2018). Research on design and futures (Candy and Potter, 2019) has shifted from a concern with forecasting to foresight (Celi and Morrison, 2017) and to speculative and critical design approaches (Auger, 2013; Dunne and Raby, 2013; Malpass, 2017), in which imagination and potential are offered as heuristics to think about plural futures (Escobar, 2018; Sardar, 2013)[5]. These studies also draw on knowledge from multiple disciplines and intercultural cooperation in exploring the possibilities of making plural futures.

In the wider context of inquiry into design and futures, at my university, the Oslo School of Architecture and Design (AHO), we have been developing a set of research and education programmes on design futures towards sustainability and climate change[6]. One such project is designBRICS[7], which explores ways to build a global platform to research the alternative futures of quality living towards long-term sustainability beyond the divides of the Global North and Global South. These studies adopt a broad, future-oriented perspective to explore the quality of life to understand climate change issues and what designers can do about them. As part of AHO's ecology of work in design futures towards sustainability, I draw on speculative design to engage creatively and critically with the contexts of posthumanism and climate change to rethink approaches to long-term sustainability between humans and nonhumans (e.g., Ávila, 2019).

Considering the complexity of sustainable future life, posthumanism and climate change, I focus on Life Styles and Life Forms and reposition and explore cosmetics in the broader context of ecology, culture and technology, which I call the Eco-Cultural-Techno sphere. Even though there are different models and frames on ecology, culture and technology on which I elaborate in Chapter 2, these frames rarely connect the three areas to discuss futures, which is necessary for designing towards sustainable futures. Through the concepts of Life Style and Life Form and my exploration of the cosmetics field, I connect different views from a range of fields to

5 This kind of practice-based speculative research uses digital and physical objects to build discursive products, interactive installation spaces, performances and the like with future scenarios for discussing futures critically and investigating their potential.

6 One research projects is profiled here: https://designresearch.no/.

7 The designBRICS website is here: https://www.designbrics.net.

make a new Eco-Cultural-Techno frame with a design focus that helps us understand complex sustainable futures and discover potential design insights for sustainable transformations. Next, I introduce my motivations for undertaking a doctorate and why I chose cosmetics as an explorative space for the Eco-Cultural-Techno concept.

1.3 Motivations

During my early doctoral fieldwork in China, I discovered that two markets in Shenzhen that had once sold electronic goods had become markets for cosmetics products and that the prominent French luxury group LVMH had created a new cosmetic brand to use Pu'er tea to produce cosmetic products in Yunnan province. Looking at these phenomena in the cosmetics sector, the emerging cosmetic markets in Shenzhen sell cosmetics products that contain more biomaterial rather than digital products that contain more plastic and silicon-based materials. The cosmetics markets and the Pu'er cosmetics have become 'organic' under the influence of the evolving economy and social movements while continuing to be driven by the market and to promote consumption.

In the last few years, sustainable lifestyle approaches have emerged in the cosmetics industry under pressure from consumerism caused by rapid development and high profits. Critiques of consumerism can be found in media coverage of overpackaged products, unfair plant trade, animal testing and identity effects beyond health effects. In response to these issues, Generation Z began to advocate for the concept of clean beauty as their notion of lifestyle (Utroske, 2020). Although there is no consensus about the definition of clean beauty, the core concept involves two aspects: humans and nonhumans (Burney, 2019). On the one hand, the ingredients used in clean beauty products should not harm human health. On the other, they should not cause environmental damage, relying instead on using safe ingredients and clean production and eschewing animal testing. 'Natural', 'effective' and 'simple' have become the keywords of clean beauty. The sustainable future of cosmetics is complex because the sector needs to pay attention to the environment and our wellbeing, both physical and psychological. A sustainable future of this rapidly developing field is about the relationship between humans, nonhumans and the environment for both individual human and ecological wellbeing.

As a freelance designer, I participated in a sustainable cosmetic design project six years ago. This project made me realise that the future, culture, technology and ecology are deeply entangled in the cosmetics industry, and it is not easy to have a direct design outcome towards sustainable changes. In the end, this project only identified certain special Asian plants as raw materials for production and some symbolic elements as design materials related to Asian branding experiences. This result did not go beyond consumerism, but the project raised more questions from a posthumanist view, such as what kind of bacteria in symbiosis on the surface of human skin can promote skin health and what kind of sustainable make-up Generation Z

may need in the virtual world.

Special Asian plants have long served as a magical image for the Western world. Similarly, the Nordic lifestyle is considered both highly desirable and sustainable. The Danish lifestyle magazine *Kinfolk* has a Chinese edition that frequently shows idealised scenarios of a sustainable, slow, earthy and communal life and has made Scandinavian life aspirational for Chinese people. After living in Norway for eight years, I realised that urban life here is both similar to and different from urban life in China. Globalisation erodes differences in urban life and makes it similar around the world. In Oslo's Scandinavian cosmetic chain store KICKS, I can buy most products that I can in China. However, it is interesting to note that not everyone in Norway can afford some of the organic cosmetics brands and the lifestyle featured in *Kinfolk*. As a Chinese person in his twenties living in Norway, this gave me a chance to understand the complex global issues of sustainability through cosmetics and everyday life. Cross-cultural cooperation shows the effectiveness of making people reach a consensus on issues that resonate with our shared everyday lives, such as water scarcity, overconsumption and environmental degradation (Sycara, Gelfand and Abbe, 2013). This is why I address the role of culture in our sustainable future from the perspective of Life Style in this research.

Considering all the views discussed above, cosmetics may be understood as complex assemblages that closely connect ecological systems, technological development, sustainable movements and popular culture. While such assemblages now may be seen as a manifestation of a new mode of consumerism, they cannot be said to have enacted a fundamental sustainable transformation. To challenge the current global-market-driven consumption model in my research, I made speculative design artefacts related to cosmetics to strengthen the differentiation process of our everyday life, such as imagining a designed organ as an alternative perfume called XIANGVEI (Figure 1.1). These designed assemblages may be said to help the current ecological crisis beyond simply replacing and updating materials or technologies. Therefore, I chose cosmetics as a research space and speculative inquiry as a research method to produce knowledge towards sustainable futures.

1.4 Design Research Orientation

In summary, my design-oriented research is speculatively oriented and situated at the intersections between sustainability, product design, posthumanist studies and research into consumer and popular culture. In my early inquires, I identified adopting a relational ontology as suitable for providing ways to look further into examining and patterning the diverse components or themes and aspects of the contexts and conditions of climate change and long-term sustainability. I saw working through speculative design in a mode of research as a means to explore these relations and materialise them through imaginary artefacts and schematics. My choice to work with speculative design was motivated by its central concern to create works, scenarios

Figure 1.1 Silicon model of the Grown Perfumer (XIANGVEI) glued to the body (Zou, 2019).

and experiences that would allow the projection and embedding of sociotechnical trends and the potential rethinking of use and uses in new contexts (Malpass, 2017). These diverse views were positioned as intersecting with one another so that designing and analysing were not set up as binary oppositions.

I further saw developments in posthumanist inquiry, the environmental humanities and publications on the Anthropocene and climate change as centrally linked parts of my projected work. They would also need critical views of technology and processual ones of change and the required transformation as an underlying part of the study. My orientation was to critically explore the domain of popular and consumer culture and develop work that would offer creative artefacts as alternatives to predominant practices of production, marketing and use. As a result, the research takes up posthumanist notions and practices of Life Forms and Life Styles. These encompass nonbinary, nondualist and non-anthropocentric views and relational thinking. Based on this emergent viewpoint, the research study consists of two heuristic and speculative design works and related research publications, along with this exegesis.

Overall, my research seeks to offer alternatives to current social material practices and models of growth and consumption by embedding arguments, relations and articulations through heuristic installation like artefacts. I have done this to elaborate, in ways reflecting design practices, alternative reshapings of the relations between design and plural futures. My research takes up these orientations in the form of this thesis, which consists of three publications, two design works and this exegesis. Two analytical contributions are offered here – an Eco-Cultural-Techno Design Speculative Approach and a Speculative Life-Style-Form Design Perspective – that present relational reframings of design and futures that span a wide range of disciplines. These reframings are discussed in relation to implications for research and potential for transfers to action and wider design-related research.

1.5 On the Study

In this theoretical doctoral research, I have been motivated to pursue three connected themes centring on speculative design and long-term sustainability through cosmetics: the potential contribution of imaginary-driven approaches, the exploration of ecological cosmetics beyond consumerism and cultural understandings of quality of life and survivable futures. I wanted to investigate these themes through speculative design inquiry as a mode of research. I was keen to draw on my experience in consumer-related design and everyday life, in design trend studies and, partly, in cosmetics design. However, I also wanted to move beyond these practices. I saw a need to examine alternative ways of approaching the undeniable pressures of climate change and investigating ways to rethink the relationships between design, ecology and futures where human-nonhuman relations are central.

Figure 1.2 Functioning LO prototype showing a future cosmetics scenario (Zou, 2020).

By thinking in relational ways, I developed the speculative design work LO (Figure 1.2) to investigate future co-living with nonhumans towards sustainability beyond current human-centric design. LO is a planetary-intelligence creature co-living with us beyond the utopian scenario of an advanced service robot in a shopping mall. Future design works in my research are about life; these are not products of the commercial world but emerge from an awareness and learning process that we are part of ecology and must have a quality life that is co-lived with all nonhumans.

In short, I wanted to use this doctoral study to propose alternative future-oriented design research methods for practices that may address the urgent crisis of climate change and challenge the fundamentals of current commercial design. Given these contexts, concerns and motivations, I drew up my research around the following core research question:

> *What might speculative design inquiry into Life Forms and Life Styles contribute to an ecological perspective and potential transformative practices for long-term sustainable development?*

I also posed two related sub-questions:

> *In what ways may exploratory artefacts in research using speculative design be configured in the present to help us shape and understand future visions and relationships between humans and nonhumans, society and the biosphere in support of long-term sustainability?*

> *Which posthuman qualities, characteristics and heuristics of Life Forms and Life Styles in the speculative design of hybrid artefacts – ecological, cultural and technical – might contribute to both human wellbeing and wider ecological flourishing in the context of sustainable futures?*

These questions concern the aim of this speculative and practice-based doctoral study: to find alternative approaches to address climate change issues by connecting speculative, ecological, cultural and technological views through the concepts of Life Style and Life Form in the context of posthumanism. Next, I introduce my analytical frame based on the research questions.

1.6 Analytical Frame

In the Anthropocene, we may need to change our ways of consuming and our mindset from a market-driven to a life-focussed approach, forming a sustainable society with improved technologies. The trajectories of human development and our technological choices are influenced by multiple social and cultural factors (Pacey, 2001). Thus, design as a process needs to reveal new social and cultural views to determine how we choose which technology to use in undertaking what kind(s) of design in the context of climate change. Ecology, culture and technology are inextricably entangled through design practice.

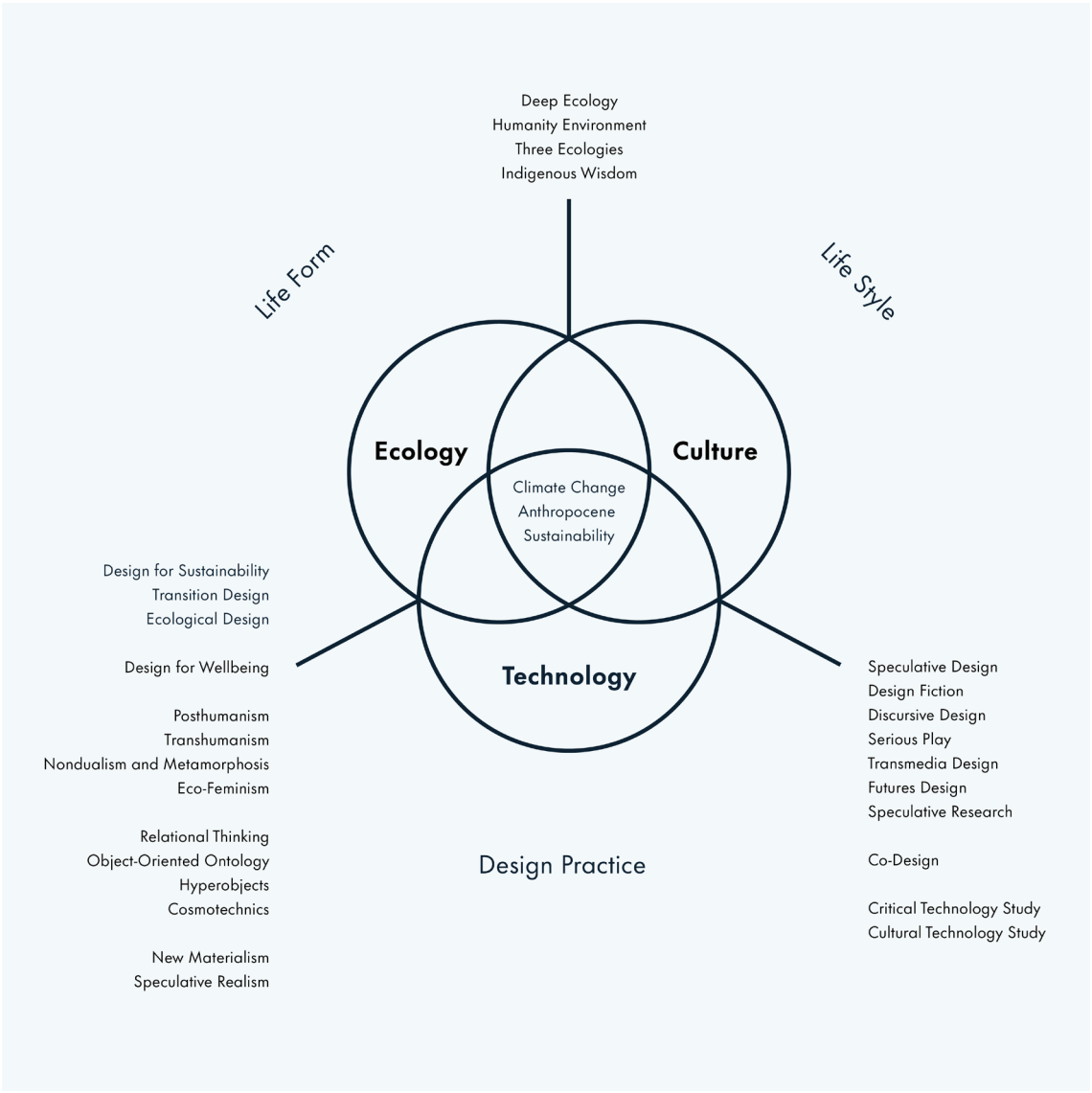


Figure 1.3 Related studies in the analytical frame (Zou, 2022).

While many studies have investigated the future scenarios of sustainability through design from ecological-social or social-technical viewpoints, research has seldom connected ecology, culture and technology. Some scholars have adopted a posthumanist perspective to elaborate on these three elements together, but little posthumanist research is connected to design research and practice. In this doctoral study, I present an analytical framework of a relational analysis based on Life Form and Life Style to investigate Eco-Cultural-Techno futures towards sustainable changes in everyday life.

In order to devise a framework that can account for the complexities of transdisciplinary studies on ecology, culture and technology, I considered using Life Forms and Life Styles from a posthumanist view to connect different views through design practice (Figure 1.3). Life Styles and Life Forms are related to the issues faced in my research: consumerism, future studies, posthumanism and climate change. The Life Styles of consumerism threaten our sustainable futures, which requires us to imagine a posthumanist co-living of Life Styles with other Life Forms based on the potential of uncertain technological changes in the future. This connected view builds up an Eco-Cultural-Techno analytical view to support design research and practice towards sustainable futures. Next, I briefly explain why Life Form and Life Style can build up this analytical frame.

I choose to capitalise Life Form to address its posthumanist perspective and its special role in my analysis. Life Form is used to analyse and define the ecological system and understand ecology by looking into the relationships between diverse life forms and the characteristics of those life forms. Form concerns the constructural assemblages of material representations for senses and experience, such as those found in architecture and design (Gelernter, 1995). Similarly, when discussing how to shape materials in a meaningful way, Life Forms may be concerned with any construction of life with an autonomous system and open-ended evolutionary potential (Ruiz-Mirazo, Peretó and Moreno, 2004). From a speculative posthumanist view, Life Forms in my study may include diverse living forms and involve humans, biological creatures on earth, artefactual entities and even fictional characters (Helmreich and Roosth, 2016). Each has a unique composition and distinctive characteristics, abilities and interactions with other creatures. This epistemology of Life Forms may provide rich material for designing alternative relationships to analyse and break the dualism between human and nonhuman, physical and digital, the past and the future, and so on.

Culture is too complicated a term to be given a precise definition. We see the word 'culture' every day but have difficulty explaining it. Life Style, here used as a lens on culture, helps us design with a cultural view. I choose to capitalise Life Style for the same reason as Life Form: to emphasise its analytical role and not to refer to any specific lifestyle, such as the green lifestyle. Life Style is taken up to define the entanglement of identity and consumption constructed by different symbolic and material relationships (e.g., Jensen, 2007; Klein, 2015). It may also refer

to developments in cultural consumerism, such as clean beauty, which uses pure plant ingredients and recycled packaging. This can be referred to as an eco-Life Style aimed at a natural, healthy and responsible social identity. Drawing on different Life Style perspectives, I develop a relational perspective on Life Style to address difference over repetition and the value of interactions over the value of objects. Difference may help us think of growth-based models and a lack of awareness of the material and resource effects of existing Life Style consumerism (e.g., Jensen, 2007; Klein, 2015) and shift to new interactions of sharing and circular economies that are not simply extensions of growth models (Korhonen, Honkasalo and Seppälä, 2018).

Technology is used as a verb more than a noun in this study, referring to its practice (Feenberg, 2017) and connecting ecology and culture through Life Form and Life Style. Technical practice is not neutral, and our social-cultural system influences technological applications (Feenberg, 2017; Pacey, 2001). Emerging technological views from Eastern cultures regarding technical practice can unite the cosmic and moral orders (Hui, 2017), which means that technology is part of ecology and culture and can connect the two. This view also supports the critical view on technology in the West's concerns about moral and ethical issues of technology. Encompassing nonbinary, non-dualist, and non-anthropocentric views and relational thinking, I connect Life Style and Life Form through technical speculative design practice to create the Life-Style-Form concept (see Chapters 4 and 5) to design and analyse our daily life from an Eco-Cultural-Techno point of view.

The proposed Eco-Cultural-Techno framework based on Life Form and Life Style investigated two kinds of sustainable futures through cosmetics: multiple-sensory form and cooperative style. The analytical process of two futures revealed that design might contribute to both human wellbeing and broader ecological flourishing in the context of climate change. The contributions of this research demonstrate that this framework can uncover how speculative design inquiry into Life Form and Life Style contribute to a relational perspective and potential transformative practices for long-term sustainability. This Eco-Cultural-Techno framework is elaborated through two schematics that I introduce in Section 1.9.

Next, I briefly outline my doctoral research method, process and structure to further elucidate this complex transdisciplinary research, its analytical frame and its contributions.

1.7 Methods, Process and Outcomes

1.7.1 Methods

As part of the designBRICS project and its scope and concerns, my doctoral study seeks to find a way to break up our dominant consumption-based everyday life beyond a business-as-usual model by investigating futures using design techniques. The main methodology for the thesis could be called research through speculative design towards sustainable futures. This is

supported by two practice-based speculative design studies on cosmetics that include aspects of qualitative inquiry (Dunne and Raby, 2013; Malpass, 2017; Parisi, 2012; Wilkie, 2018). The speculative design research methodology involves inquiry through making diegetic prototypes, socio-technical imaginary artefacts and contexts and experimental installations to rethink sustainable everyday life[8].

Some scholars have critiqued the focus of speculative design inquiry on specific materialisation processes (Tonkinwise, 2015; Ward, 2021). Further, speculative design has been found to have difficulty in dealing with social-technical systemic problems and to take action on wicked problems because of its focus on specific aesthetics and problems. I use diverse but entwined design research methods from making physical prototypes and digital artefacts to installations that do not focus on the appearance of artefacts and specific problems. They are concerned with materialising problems, making analytical frames and unlocking the potential to anticipate Eco-Cultural-Techno futures. It is my hope that they do so by analysing new relationships from materialisation processes and completed works that seek to adopt a broad view and tackle the wicked problem of climate change to facilitate a space or atmosphere that allows design transitions to happen.

In my inquiry, I conduct research by using design artefacts and the processes of their making to understand problems from diverse perspectives, including my own life experience, and make artefacts to unite different kinds of knowledge to transcend disciplinary boundaries and achieve a relational implementation. My Approach includes diffractive processes (Barad, 2007; Hill, 2017), which are covered methodologically in Chapter 3. Haraway (1997) conceptualised the diffractive in terms of an optical metaphor through which we can perceive and critique processes and patterns generated by the spreading of waves around objects or obstacles. In philosophy of science and feminist science and technology studies, the diffractive approach has been used by Barad (2007) to refer to relations of objects to contexts, systems and environments; that is, as multiples and ripples and bounced and patterned. The point of considering this diffraction is to engage us in critical, self-reflexive and multiple ways of seeing and being that are connected to engagement in the world and how matters in that world could be different. For Barad (2007, p. 25), the diffractive may be used to 'provide a transdisciplinary approach that remains rigorously attentive to important details of specialised arguments within a given field, in an effort to foster constructive engagements across (and a reworking of) disciplinary boundaries.' In my work, I address the ways that different aspects, angles and overlays are used to explore the potential of sustainable futures and problems through designing new

8 These diverse design future-related prototypes and artefacts are put into a new context for the audience to raise questions and anticipate new social-technical futures (Auger, 2013; Dunne and Raby, 2013; Malpass, 2017). The experimental installation spaces may bring audiences into close or direct experience, understanding and participation in the future to produce embodied and plural knowledge (Kuzmanovic and Gaffney, 2017). By integrating poetic techniques, speculative design artefacts can function as performative outcomes that inform alternative futures (Markussen and Knutz, 2013).

relationships for the purpose of analysing.

Design research is conceptualised here as a 'making-analytical practice' (Morrison, Mainsah and Rygh, 2019, p. 2271)[9]. In contrast to previous sociological or cultural investigations of ecology or technology, my study examines unsustainable cultural phenomena and uses design to provide alternate options for sustainable Eco-Cultural-Techno futures. These possibilities also go beyond the scope of commercial design research and the endless growth logics of the existing capitalist system.

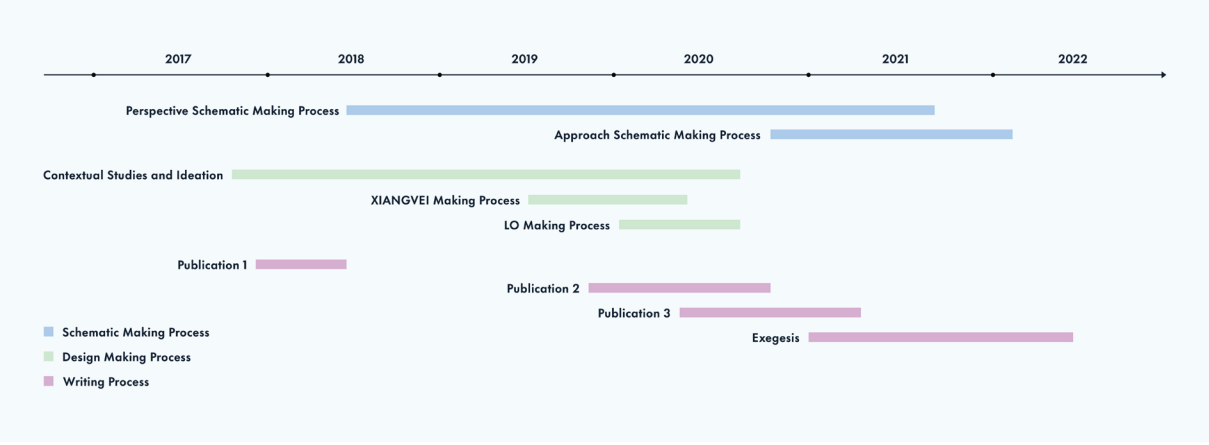


Figure 1.4 Timeline of different processes in this doctoral research (Zou, 2022).

1.7.2 Process

My research began in 2017, but much of it has been constrained by the global Covid-19 pandemic, which has placed additional demands on working with futures through design and the resulting theoretical focus and suggested prospects. The research process uses mixed methods supported by different design techniques and tools, including creating different design cooperations, prototypes and schematics (Koskinen et al., 2011), where attention is also paid to processes of designing (Lury, 2018)[10]. These different methods led to three research outcomes at different stages (Figure 1.4), which are connected as a theoretical whole on Eco-Cultural-Techno futures: schematics (the Eco-Cultural-Techno Design Speculative Approach schematic and the Speculative Life-Style-Form Design Perspective schematic), design cases (XIANGVEI

9 This knowledge is materialised through the different design activities of the research. This making-analytical practice connects the analytical process with dynamics between research methodologies, research methods, design techniques and design tools, which could be used to reflect and analyse design researchers.

10 This refers to the dynamics of creating and researching and their intersections and influences on one another. Design cooperation in this research includes joint curating for an exhibition, creating prototypes with a global collaborative and co-authoring research and the wider designBRICS dialogue spaces and processes. Design prototypes with different formats involved multiple design techniques and tools for conceptualising, sketching, drafting, making, trialling, implementing and reviewing. Finally, creating visual schematics (Gansterer, 2011) for the design work and for analysis was supported by design techniques and tools like mapping, visualisation and modelling, along with dialogues on the visualisations and forms of the works with designers and researchers.

and LO) and four documents (three publications and this exegesis).

Making schematics occupied almost the entire process of this research to connect contextual studies, analyse design works and form the theoretical framework. For convenience, I use the terms 'Approach schematic' and 'Perspective schematic' as short forms.

Drawing on mixed methods, I developed two speculative design projects: XIANGVEI and LO. The research methods in both projects included contextual studies, speculative making and drafting publications[11]. I made two speculative design works for each project. The ideation process of design works involved field and case studies of cosmetics in Norway, Italy and China and cooperative prototype making in Shenzhen. I attended the XIANGVEI making process in Shenzhen for seven weeks. Due to Covid-19, the LO making process was conducted remotely. The two design works have related publications (Publications 2 and 3, respectively) to narrow their context and focus.

In addition to Publications 2 and 3, the writings include Publication 1 and this exegesis. Publication 1 is an analysis of the gaps in the literature review. In terms of method and rhetoric, the exegesis has led me to engage me in reflecting on a process of moving between making and analysis and abstracting notions, ideas, values and propositions embedded in the works into conceptual reframings and reflections. The publications and the exegesis are both integral parts of the thesis.

1.7.3 Relationship between Method, Process and Outcomes

The three processes (designing, making schematics and writing and analysing) and outcomes are connected and support one another in making diverse contributions (Figure 1.5). This study focuses on the intersections between sustainability, speculative design, Life Style, Life Form, posthumanist studies and sustainability. I saw relational thinking, speculative making and cooperative making as means to explore these intersections and relations and materialise them through imaginary artefacts, schematics and writings.

Initially, I conducted contextual studies of Life Style and Life Form by making schematics. This led me to plan three speculative design projects on cosmetics, one focusing on Life Style, one focusing on Life Form and one focusing on a mix of Life Form and Life Style. Unfortunately, the last project has not yet been completed because of Covid-19. While making the two design works, I discovered two design focuses – sensory form and collaborative style

11 The contextual studies are conducted through cases, literature studies and sensory field studies. Speculative making was used as a way to build up new relationships to explore the potential and problems of future everyday life around Life Forms and Life Styles. Finally, the publications in this research are a practice to expand knowledge by combining different disciplinary understandings from a design and relational perspective.

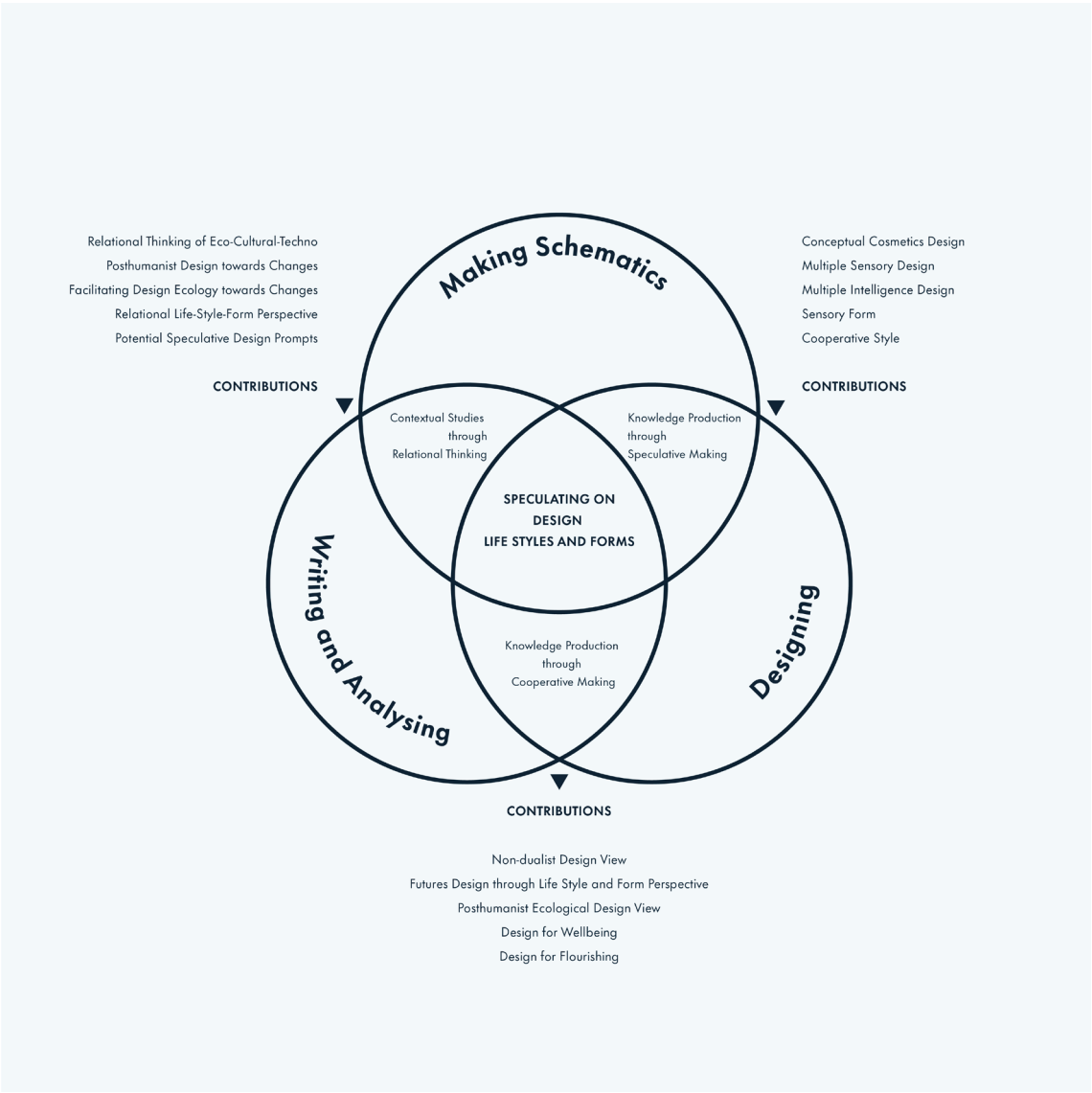


Figure 1.5 Relationship between method, process and outcomes (Zou, 2022).

– and further explored multiple sensory design and multiple intelligence design in my writing.

Writing was an analytical process that advanced my understanding of non-dualist posthumanist ecological design views. The publications reveal a relational view of Life Style and Life Form that could benefit design for wellbeing and flourishing. Both the writing and design work allowed me to improve the Perspective schematic and recognise the ecology of my Approach to developing an Approach schematic. These two schematics were arrived at through dialogue with my design work and writing; more details of this process are provided in Chapter 3.

Schematics become analytical contributions that present relational reframings of design and futures that cross a wide range of disciplines through speculative designing, inquiries and writing. These reframings are examined in connection with their possible effects on future research, prospective applications in broader design practice and research and the design atmosphere for change. As a contribution to design inquiry, the schematics offer ways to build up new relationships through design to understand these relationships more deeply and investigate alternative human actions and the other potential of sustainable futures. The three processes with their outcomes became a loop for producing knowledge that included plurality, not a separation of experience and knowledge (e.g., Escobar, 2018).

Next, I briefly introduce the three research contributions, design works, analytical schematics and publications to offer an overview of this research as a whole.

1.8 Design Works

As a designer engaged in making artefacts and having chosen to develop a few of those artefacts for this inquiry, I adopted designing in a speculative and poetic mode as my primary research method. I bring design techniques of physical and digital materialisation to my developmental work[12] to connect different elements, aspects and agencies in a relational implementation. This took the form of two main subprojects or design works – XIANGVEI and LO – with a number of contributing elements (see Publications 2 and 3 and Chapters 4, 5 and 6).

While these two works relate to big, planetary, systemic issues, I drew on the notion of 'serious play' (Flanagan, 2009; Tronstad, 2010) in their creation and analysis. This concept has been taken up in digital culture and gaming, not just commerce (Schrage, 2000) as a stance or way of framing work so that irony and playfulness can be included in a non-literal, abductive, poetic and speculative mode of inquiry (e.g., Morrison et al., 2021; see Chapter 2). Considering

12 This is similar to Martín Ávila's approach to diverse projects, such as his postdoctoral project *Symbiotic Tactics* (https://www.martinavila.com/projects/symbiotic-tactics/). Ávila developed different speculative and poetic 'devices' to explore the potential cohabitating relationships between humans and nonhumans, including scorpions and insects.

'serious play', I made performative and demonstrative prototypes with mechanical structures instead of biological materials, which are hard to make and maintain. These prototypes are close to the audiences to help them understand the operating mechanisms and interact with the prototypes.

The goal of the XIANGVEI project was to explore alternative sustainable Life Styles related to olfactory, scent, perfume, bio scents and so on to challenge aspects of the existing consumerist cosmetics industry. In that project, I explored alternative actions and behaviours through designed organs using ecological materials to produce perfume on human bodies. The anticipatory and speculative futures of XIANGVEI may be connected to embodied knowledge, our bodies and our Life Forms.

Compared with XIANGVEI, the LO project[13] was established to explore, from a posthumanist perspective, the sustainable relationships between different Life Forms, humans, plants and artificial intelligence (AI) in the cosmetics area. I developed LO as a digital creature that may cooperate with humans and nonhumans through light. The anticipatory and speculative futures of LO reveal Life Styles based on diverse cooperative relationships that may create a flourishing culture for both humans and nonhumans.

1.8.1 XIANGVEI

In the first subproject, XIANGVEI (Figure 1.6), I researched future Life Forms to gain insights into sustainable futures by redirecting human enhancement and rethinking the scent culture of the cosmetics industry. By this, I mean redirecting biological enhancements to sensory ones. The work addresses a number of related questions. What kinds of Life Style elements might we need to consider facilitating sensory enhancement that motivates sensitivity to the ecological? How might a focus on smell be taken up to realise this? What might relations between materials and the environment need to be included in the work? Might there be a need to develop several parts of this work to encompass a set of key relations between the ecological, the cultural and the technical?

XIANGVEI is a speculative design organ for the future. It may be a kind of sensory enhancement in which humans can use different plants to produce location-based perfume and understand the language of plants by recognising their radiation and computation technology. XIANGVEI may be understood as a means to highlight sensory enhancement to better understand the environment that starts from a speculative and imaginary perfume culture beyond

13 The initial plan was to carry out three design subprojects, but due to restrictions imposed by Covid-19, only two were completed. The third project is set to connect the XIANGVEI and LO projects, focusing on Life-Style-Form. The question examined in that project is whether we protect biodiversity and promote multispecies cooperation through human sensory practices. I plan to make a design interactive installation in the city to study the integration and potential partnership between the smell of plants in the city and urban sustainable living for humans.

Figure 1.6 Silicon model of the Grown Perfumer (XIANGVEI) organ, with instructions for its use and installation (Zou, 2019).

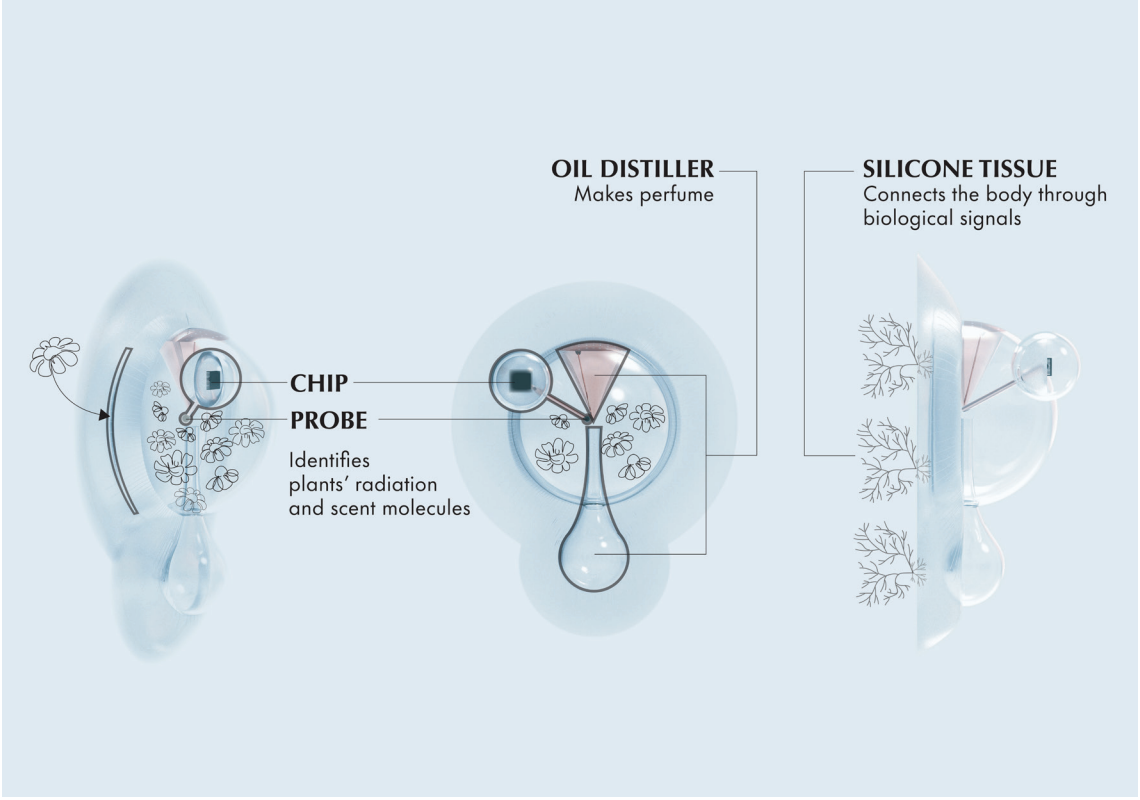


Figure 1.7 Digital model to show the structure of the Grown Perfumer (XIANGVEI) (Zou, 2019).

GROWN PERFUMER INFORMED CONSENT

XIANGVEI Lab
Patient Name:
Date of Birth:

GENERAL INFORMATION

This enhancement provides you with:

1. A surgical procedure performed to 'plant' a new device on your body.

2. An opportunity to put different plants into the device to produce perfume in your body.

3. A way to understand the 'language of plants' through their flowers and leaves and use of the device.

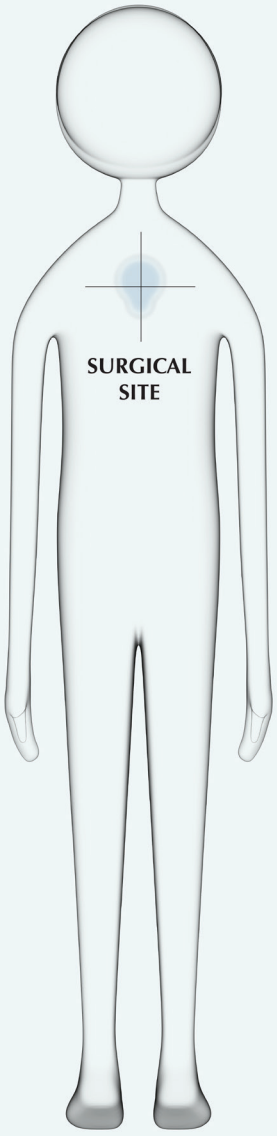
DISCLAIMER

Please read this document carefully and have all of your questions answered before signing your consent as follows:

1. I authorise XIANGVEI Lab to perform the following procedure.

2. I recognise that the plants may cause uncomfortable feelings for me, and I accept this as part of my engagement to understand them.

3. I agree to take a course on how to use the Grown Perfumer.



DEVICE

RISKS

You acknowledge that every surgical procedure involves elements of risk. These are twofold:

- **The Astringent Odor Produced by the Organ**

Different plants produce different odours. After your surgery, you will need to learn how to use the new organ and the knowledge of perfume making as part of learning with nature.

- **Persistent Plant Anxiety Causing Discomfort to the Human Body**

Changes in the natural environment and climate may influence information your receive from plants about their conditions. This may cause you physical discomfort to adapt to and to endure.

CONSENT SIGNATURES

Patient

Operator

Figure 1.8 The consent letter for operation and use of the Grown Perfumer (XIANGVEI) (Zou, 2019).

the current human physical-ability enhancement of solutionism. In addition, the work assesses future human plastic surgeries from an Eco-Cultural-Techno point of view to see whether they may play a role in sustainability.

With a diffractive research process, I made XIANGVEI to use as a research device in a variety of scenarios and contexts to connect knowledge from different disciplines and generate insights into sustainable scent futures. First, XIANGVEI may be a smart wearable (Figure 1.7) to understand plants' signals and create scents as unique perfumes. This setting was drawn up to explore and understand the potentials of technology. Second, I made a XIANGVEI installation to help people experience XIANGVEI directly. The installation mimicked the experience we had when we owned XIANGVEI and helped us rethink the value of scent-embodied knowledge. Third, XIANGVEI may be a new perfume of sensory amplification to understand the sustainable meaning of human enhancement. Finally, I created instructions for XIANGVEI's installation and use as a design fiction (Figure 1.8) to elaborate on the problems and potential of future scents from an Eco-Cultural-Techno perspective.

XIANGVEI argues that multi-sensory futures could contribute to long-term sustainability by facilitating new relationships between humans and nonhumans and a new way of gaining embodied knowledge. The work is elaborated in Publication 2.

1.8.2 LO

The second subproject, LO (Figure 1.9), explored the potential future Life Styles of humans to develop insights into sustainable futures by reshaping the relationships between themselves and nonhumans. The work addresses a number of related questions. What kinds of artificial Life Form may need to be considered to build up cooperative relations between humans and nonhumans? How might we use light as a medium and material and light-related knowledge to facilitate this relationship? In what form might the dynamics between light, natural intelligence and AI be realised in relation to a wider ecological perspective on cosmetics?

Conceptualised as a kind of digital creature, LO may use solar energy to be an autonomous creature that provides diverse kinds of light to enhance the wellbeing of humans and nonhumans and cohabit with them. Furthermore, with different sensors that recognise a wide range of data like vision, scent and movement, LO may better understand humans, nonhumans and the environment to provide more diverse forms of light with different enhancing biological and cultural effects through AI technology. Thus, LO may connect the human and nonhuman and become a way to share human knowledge with nonhumans and build cooperative relationships towards flourishing ecological futures.

LO was presented in physical digital prototypes, digital illustrations of its mechanism and future scenarios through sketching, physical and digital prototyping, mapping, illustrating and

Figure 1.9 A functioning LO prototype showing the structure of the base and adjustable head with vision sensor and LED light (Zou, 2020).

Figure 1.10 Speculative scenario in which LO recognises a plant, produces light appropriate for its growth needs and anticipates its future ecological system through digital technology (Zou, 2020).

Figure 1.11 Playing cards embodying posthumanist perspectives on speculative futures and current approaches to developing Eco-Cultural-Techno cosmetics for humans and nonhumans (Zou, 2020).

co-writing workshops. LO was used as an exploratory, heuristic and poetic tool for a diffractive mode of inquiry. The diffractive process was a fictional development process of LO from an innovative cosmetic tool to a digital ecological creature. Firstly, I made physical prototypes to demonstrate how LO may contribute to the wellbeing of humans and plants through light (Figure 1.10). This scenario was created to critically discuss how we use advanced technology in cosmetics and show the potential of non-human-centric design through the knowledge of light's role in human and plant health, digital twin technologies, and so on. Second, I used digital illustrations of the LO sensory system and working mechanism to show how to make LO intelligent and advanced. This scenario sought to understand how to combine embedded and embodied knowledge to build an equal relationship between humans and nonhumans. Lastly, I made playing cards (Figure 1.11) to imagine other possible sustainable digital creatures based on different natural elements: water, microwaves and so on. These plural-designed creatures show that design may build cooperation built on equality between humans and nonhumans at the planetary level and thus contribute to ecological flourishing.

LO argues that building cooperative cultures between humans and nonhumans from the Eco-Cultural-Techno viewpoint by designing non-anthropocentric artefacts is the key to long-term sustainability. The work is elaborated in Publication 3.

Next, I turn to the research outputs leading to and connected with the work described above.

1.9 Analytical Schematics

Making schematics is integrated throughout this thesis. That process helped me connect knowledge from different disciplines to develop analytical perspectives related to design. Initially, the schematics were made to connect different research streams to form an analytical framework. Once the design projects began unfolding, the schematics were refined and supported my design projects as a framework for analysis and a space for design exploration. Making schematics, analysing and designing become interactive powers to drive the research forward. The Approach schematic illustrates the complex system in which design is situated in the context of climate change, connecting different fields of knowledge to form the Eco-Cultural-Techno design frame that is essential for sustainable design. The Perspective schematic relates to design through Life Form and Life Style, offering prompts to better analyse sustainable futures and identify potential design possibilities. These two schematics serve as analytical contributions that are presented visually to better understand the complexity of my research.

Given my interest in matters of altering notions and offering alternatives to current consumer culture and the domains of cosmetics, environment and technology, I saw the need to read the Approach schematic (the macro level) and the Perspective schematic (the micro level)

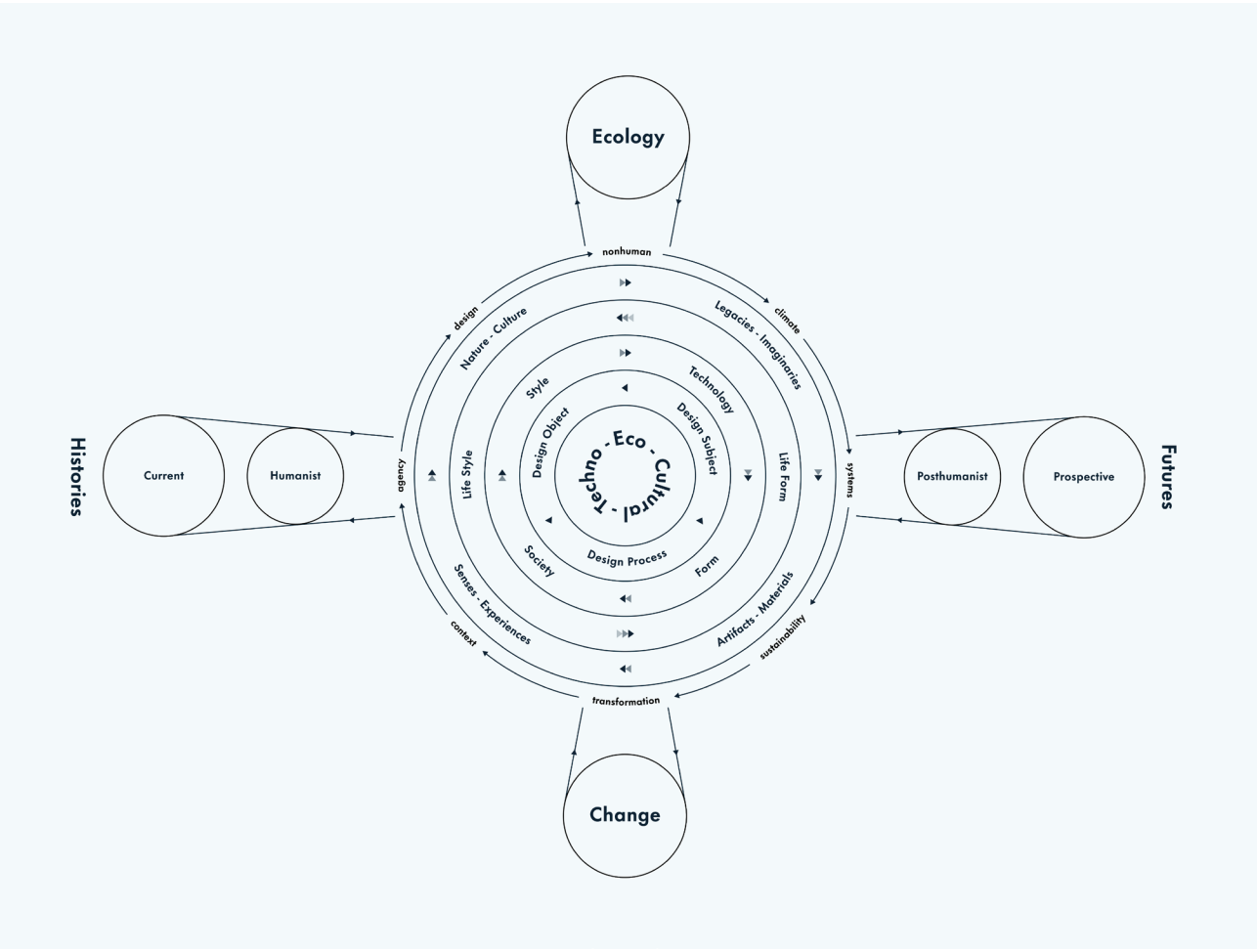


Figure 1.12 A schematic of an Eco-Cultural-Techno Design Speculative Approach for sustainable futures (Zou, 2022).

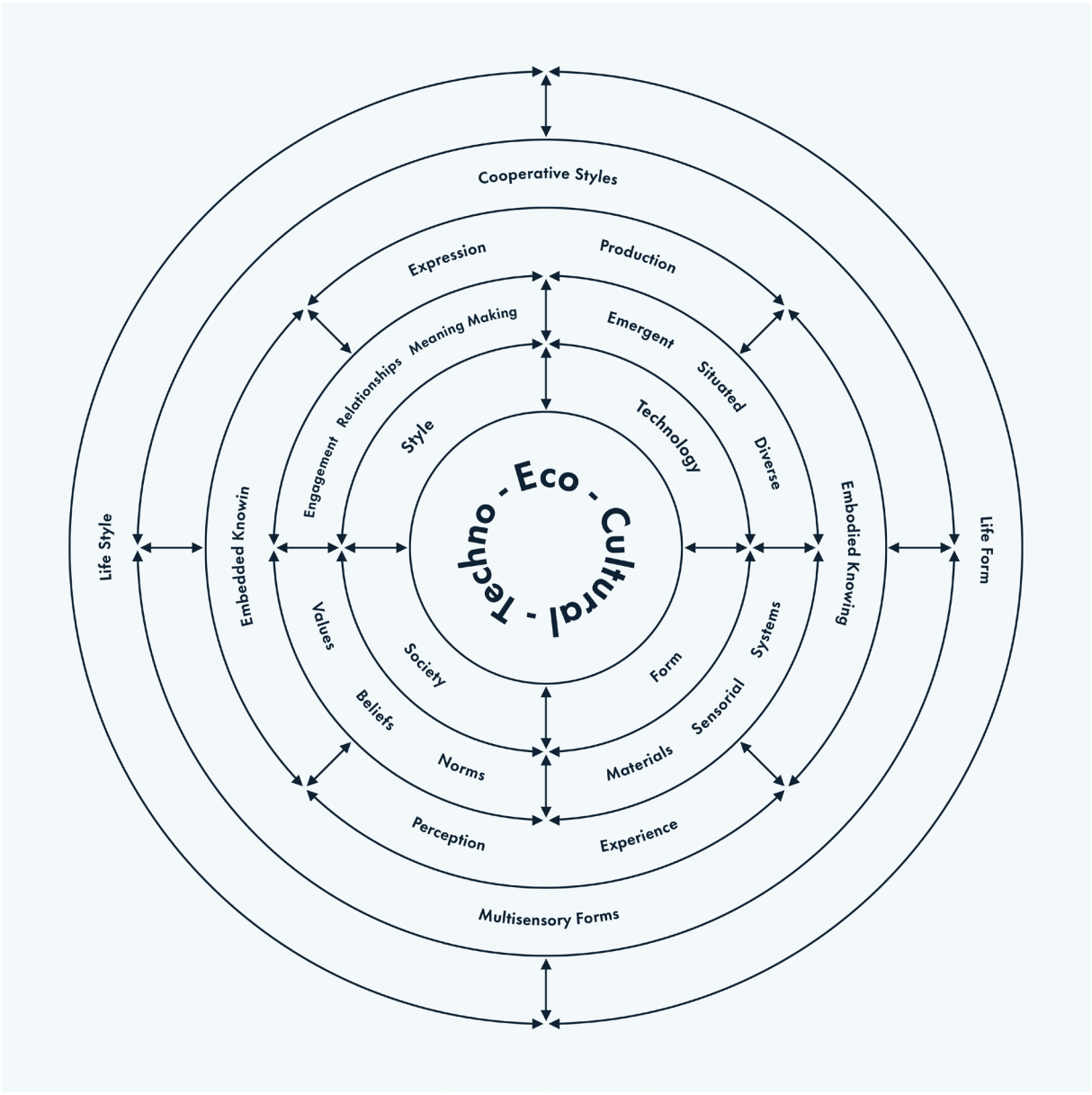


Figure 1.13 A conceptual schematic of the Speculative Life-Style-Form Design Perspective (Zou, 2022).

together.

The Approach schematic (Figure 1.12) is a macro-level conceptualisation of integrated relational thinking and design ecology towards climate change and sustainable changes. It refers to considering posthumanist views and three aspects – ecology, culture and technology – together through the two inseparable concepts of Life Style and Life Form. The Approach schematic is elaborated in Chapter 4 and discussed through two design works in Chapter 6.

The Perspective schematic (Figure 1.13) refers to connecting viewpoints and concepts from Life Form, Life Style and posthumanism to propose a speculative analytical design frame. With diverse and multiple contextual aspects – style, society, form and technology – the Perspective schematic provides a conceptual space to analyse transdisciplinary knowledge and prompts the design of pluralist objects by connecting and diffracting different kinds of knowledge. The Perspective schematic is elaborated in Chapter 5.

The Approach schematic is an overview of the design ecology towards Eco-Cultural-Techno futures through Life Form and Life Style. This design ecology system reveals the complexity of design elements that need to be considered to address the potential changes towards long-term sustainability. The Perspective schematic is a granular-level conceptual and analytical viewpoint through a relational perspective of Life Form and Style. This Perspective introduces elements close to design and daily life that like a compass help build relationships between humans and nonhumans through design towards Eco-Cultural-Techno futures.

1.10 Research Publications

Publication 1: Conference paper
Zou, Y. (2018). 'Design for quality life: Speculative transformation of lifestyle'. Design Microconference, 5–7 September, Design School, Kolding, Denmark. ISBN: 978-87-93416-32-1 https://www.designskolenkolding.dk/en/publications/design-microconference

This paper argues that Life Style can be a promising practice space for designers to carry out transition design practice through speculative design by addressing designers' creative and aesthetic skills. It was a very early trial of investigating design problems in the context of climate change. Three findings are addressed in this paper: transition design and speculative design are future-oriented for the long term and characterised by a grander vision that might push the boundaries of clichés. Furthermore, the social-technical nature of these two design approaches qualifies them as applying to everyday life. Meanwhile, in many ways, these two design approaches complement each other. Combining transition design thinking and the creative skills used in speculative design like storytelling and prototyping is possible as a new design approach that addresses transforming consumer Life Styles into something less

destructive. The designer's vital role in transformative design for future Life Styles is shown through new understandings of the aesthetic experience, such as an object-oriented ontology. Narrative prototyping concerning the aesthetic experience makes people sense the possibility of a future Life Style. It also triggers an intention to transform everyday lives. Life Style is still a complex system for design practices from the business-as-usual perspective. This is crucial because designers need an innovative framework to integrate their new design knowledge with the real world when working with commercial companies.

This paper explores the relationship between transition design and speculative design within sustainability through a Life Style view. It argues that Life Style can serve as a space for speculative design with transformative thinking to question current design methods like human-centric design and to rethink the essence of design, futures, aesthetics and style. The additional exploration presented in Chapter 2 demonstrates the role of speculative design in sustainable transition; some design and research methods appear in Chapter 3.

Publication 2: Journal article
Zou, Y. & Morrison, A. (2022). 'Sharpen your anticipatory senses for sustainable "scentory" futures', Futures, 135. Available at: https://doi.org/10.1016/j.futures.2021.102856.

This article investigates speculative design and the olfactory concerning the development of potential future Life Forms and Life Styles for longer-term sustainable and survivable futures. Referring to anticipatory design, we reference the anticipatory speculative inquiry literature from the perspectives of design, culture and posthumanism. Cultural, historical and contemporary material on olfactory and sensory-related design is presented. The article reaches beyond current consumerist market practices in cosmetics and perfume. It poses and projects alternative relations between the environment and biomaterials, the olfactory, embodiment, the sensory and the perceptual. Drawing on research through design, a speculative olfactory project called XIANGVEI is conceptualised, prototyped and discussed in an ecological anticipatory design futures frame. Speculative concepts, artefacts and their implications are deployed to pose and elaborate the ways in which future Life Forms and Life Styles may be positioned in and contribute to wider systemic and collective systems of shaping futures knowledge through 'scentory' design.

This article is one result of my first practice-based PhD research project, XIANGVEI; the article explores the futures of perfume and scent culture through the Speculative Life-Style-Form Design Perspective that I conceived. I argue that sensory futures may build up nonhuman-centric and nondualist relationships between humans and nonhumans through a new scent culture that is crafted for a sustainable future. This article is discussed further in Chapter 5 and Section 6.2.

Publication 3: Journal article
Zou, Y. (Submitted in August 2022). 'Toward designing Eco-Cultural-Techno posthumanist futures: An investigation using speculative cosmetics'.

This article explores a new speculative design inquiry approach for shaping posthumanist relations between humans, nonhuman living things and artefacts towards long-term sustainable futures following a heuristic inquiry type of design research. The article describes the design of a one-of-a-kind speculative cosmetics artefact called the Light Origin (LO). Further, based on a posthumanist relational ontology, the inquiry in this study uses an analytical and design-centred frame that combines ecology, culture and technology through a focus on Life Forms and Life Styles. The design outcomes suggest how design can facilitate posthumanist cooperative futures by sharing human knowledge with nonhumans, connecting embodied and embedded knowledge and considering rich meanings of design elements beyond human-centric and consumerist design culture. The article argues for an Eco-Cultural-Techno Design Speculative Approach that can contribute to long-term sustainability through speculatively making and analysing alternative posthumanist cooperative relationships.

This article is one result of my second practice-based PhD research project, LO. This article explores the cosmetics field by addressing the speculative and relational perspective of Life-Style-Form that I developed. I argue that sustainable futures should feature a cooperative culture, with different modes of cooperation within new relationships between multiple Life Forms. This article is discussed further in Chapter 5 and Section 6.3.

In reviewing my publications, the first article identifies a clear research space of sustainability that addresses speculative design inquiry, quality of life, and Life Styles. The second and third publications argue for sustainable futures by creating new relationships through design from a sensory and cooperative perspective. In this exegesis, the publications are analysed and positioned into a whole to be connected to explain and reinforce the research findings and insights.

In conclusion, the approach of the three publications is to investigate the transformative futures of Life Style and Life Form through speculative making. The first publication offers an explorative space for my future research to develop an Eco-Cultural-Techno Design Speculative Approach through the perspective of Life-Style-Form towards long-term sustainability. Publications 2 and 3 demonstrate multisensory and cooperative futures of Life Style and Life Form through designing speculative, posthumanist, heuristic and hybrid artefacts that address nondualism and non-anthropocentrism for ecological flourishing.

1.11 Outline of the Thesis

The introduction orientates the reader to the context, purposes and focuses of the research. It briefly introduces its findings, contributions and potential applications. This academic thesis has a relational structure achieved by compilation (with an exegesis and publications), not a linear one, and the different chapters in the exegesis and the publications are closely connected. The exegesis is a meta-text, and the publications are not mere appendixes. This is an 'academic with practice thesis' as conducted in Norway (not only a thesis by practice but also an interplay between practice and academic research).

Chapter 2, as a literature review, investigates existing views on sustainable design, speculative design, Life Style, Life Form and posthumanism to construct an Eco-Cultural-Techno view of design for further future-oriented research. The content is the basis of other chapters.

After Chapter 2, the three publications should be read to offer a big-picture view of two design projects with details and reveal the focus on Life Style and Life Form. Chapter 3 details the methodology, methods, design techniques and tools used throughout this doctoral study. It contains details about designing, making diagrams, and the analytical and writing processes that help understand how this research was completed.

Chapters 4 and 5 are best read together to observe a theoretical relational framing through two schematics that elaborate posthumanist and relational perspectives on and through practice. Chapter 4 presents and examines what I have drawn up and discussed as a theoretical transdisciplinary relational Eco-Cultural-Techno Design Speculative Approach by using a conceptual schematic that addresses complex research dynamics through designing in climate change. First, I outline the Approach through a schematic to summarise its key components and show its dynamics and layers. Then, I introduce the details of the Approach schematic in its context and three intersecting views. Finally, I discuss the complexity and relationships of all the elements of the Approach to argue that it has the potential to work with climate change and the Anthropocene from Eco-Cultural-Techno viewpoints through design.

In Chapter 5, I unpack and relate my Approach to a Speculative Life-Style-Form Design Perspective built on contextual studies and my two speculative design research projects. First, I present the main argument and components of the Perspective through a relational schematic connected to the Approach schematic. Then I discuss how I position my own work in relation to the Perspective schematic.

In Chapter 6, I discuss how I position my own work in relation to the Approach and Perspective schematics and reveal conceptual sustainable futures and the potential of

sustainable design. In Chapter 7, I discuss some directions provoked by the new Approach schematic and its further work with plural thoughts to inform collective visions of the climate crisis. Next, I introduce solid future sustainable actions based on my own future. Then, in Chapter 8, I summarise the research matters' focus, outcomes and new knowledge and suggestions in the context of climate change. This serves as the conclusion of my research.

1.12 Chapter Conclusion

Speculative design is an emerging method to research futures through design but lacks knowledge of precisely how we design towards sustainable futures. By contrast, traditional strategy design lies mostly within the trend of market-driven futures. Beyond this capitalist location, I bring in posthumanism and its relational thinking to address the importance of imagination and creativity in design research and practice to materialise alternative sustainable values and coevolving and cohabiting relationships between humans and nonhumans.

While design has an inherent relationship with consumerism, I investigate alternative materialisations of the Life Style and Life Form concepts in the cosmetics field from a posthumanist perspective. I conducted the research by designing, drawing, diagramming, prototyping, and so on. In an interplay between making and analysing, I propose an Eco-Cultural-Techno Design Speculative Approach developed through speculative inquiry and the new concepts of Life Style and Life Form to address climate change issues, connected to the offer of a Speculative Life-Style-Form Design Perspective.

In Chapter 2, I review the key research themes of DfS, speculative design, Life Style and Life Form, posthumanism and relational thinking. The chapter positions my research within existing theoretical perspectives and related projects to inform the research frame and connect with materials and processes in the making of the two works crafted to develop analytical reframings, discussions and directions.

2. Literature Review

Engaging in research through designing in a speculative mode of inquiry in the context of climate change and the Anthropocene; that is, in terms of the dynamics of sustainable design, it poses several possibilities and problems when drawing together the relevant literature. The literature review presented is thus transdisciplinary in its orientation towards a relational view. It is arranged around four main domain-based themes: 1) changes in DfS, 2) speculative design, 3) Life Style and Life Form and 4) posthumanism. These are basic contextual materials for further design projects and the Approach schematic (Figure 2.1).

I first present changes in DfS to explain why we need sustainability in design and what DfS might do next. Second, I review speculative design to position my work in this design field and outline its potential for framing and placing the contribution of imaginary and speculative work within the broader design approach to long-term sustainable futures that are connections of the ecological, the cultural and the technical. In the second section, I present my reasons for revising current sustainable design and use speculative design to enact a prospective view of sustainability (see Publication 1). Third, I move on to review the concepts of Life Style and Life Form and their related sustainable design approaches in view of design for wellbeing. The aim is to show the potential of Life Style and Life Form to connect technology, culture and ecology. Finally, I introduce posthumanism as a key research field that allows us to encompass relations between elements, agents and actors, whether human or nonhuman.

2.1 Changes in Design for Sustainability

2.1.1 One Human Reality and Two Human-Made Concepts

We have one key reality: our environment has been becoming increasingly unliveable, even though we do not fully experience that reality in the city and other human-made, developed spaces. One obvious example is climate change, as is clear from a 2018 report by the Intergovernmental Panel on Climate Change's (IPCC):

> Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C (high confidence). These risks depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options (high confidence). (2018, p. 4)

Greenhouse gas emissions must be decreased by half by 2030 and to zero by 2050 to have a fair chance of keeping global warming below 1.5°C. The most recent IPCC report shows that we need to act now, or we will never successfully tackle climate change. Unfortunately, what we have done in the past is not enough for many countries, although they have signed the climate change agreement. The 2022 war in Ukraine also revealed the paradox of energy security and

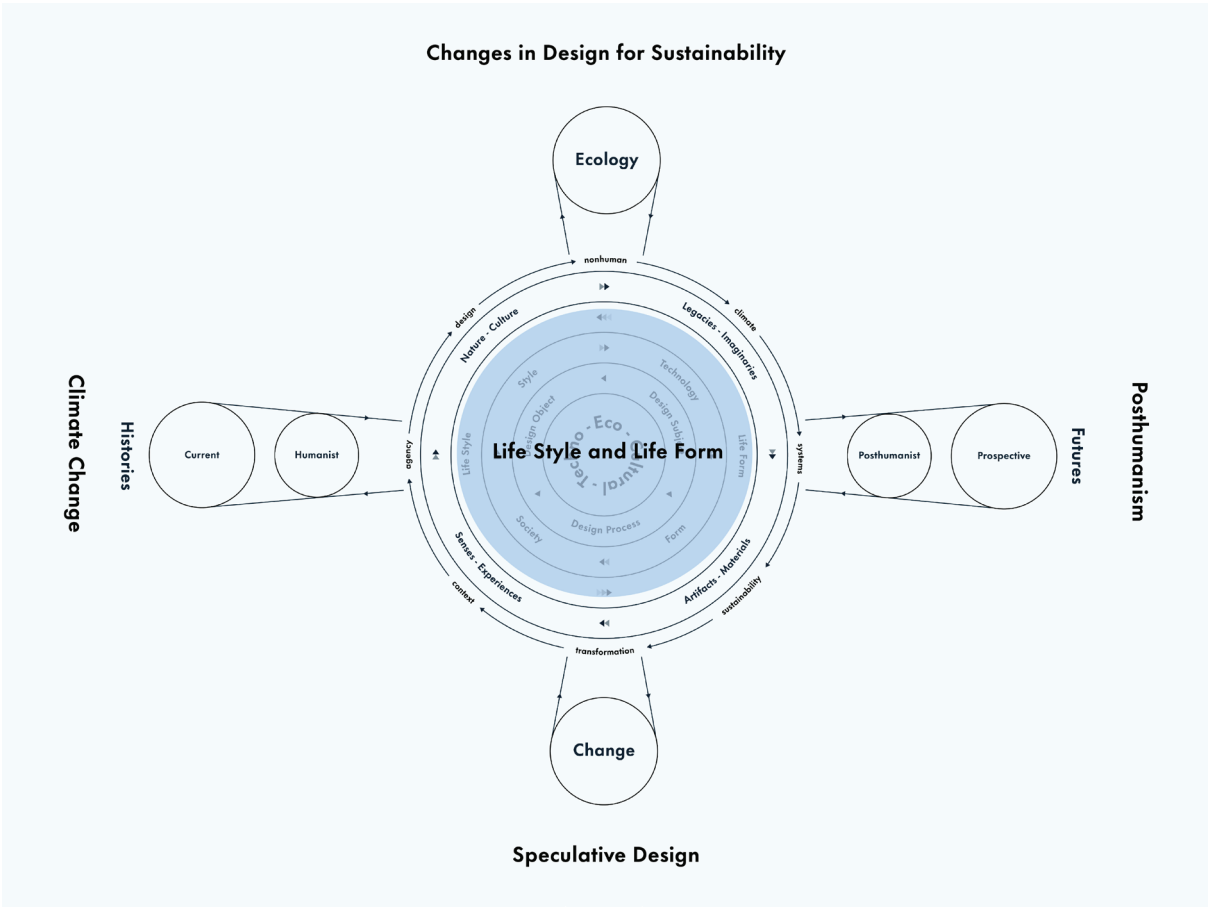


Figure 2.1 Key themes in the Eco-Cultural-Techno Design Speculative Approach (Zou, 2022).

climate change. From our daily cultural life to geopolitical choices, human behaviour is changing the earth's environment in myriad. We have to acknowledge that we impact and interfere with the environmental system, which could lead to a human crisis that we will not survive. Two profoundly human concepts have been created in the face of these pressures. One is the Anthropocene, which is about time. The other is sustainability, which is about a goal.

Although the Anthropocene is a geological term that the full scientific community has not officially accepted, the emergence of this term shows that scientists have a new understanding of how human activities affect the planet through global change, which summarises the growing interference of human beings with the Earth's metabolism and its relation to the natural variability of global ecosystems. The human interference in the earth's systems has increased dramatically over the last century and has now reached a level on the same order of magnitude as many natural processes on Earth. The term Anthropocene[14] has been proposed to mark an era in which the human impact on the Earth system has become a recognisable force. Presently, no signs indicate a deceleration or reversal of this development. Coping with the consequences of global change has thus become a challenge with unknown prior dimensions for human society. It goes far beyond analysing changes in the global climate system; rather, it comprises all the physical, biogeochemical and societal processes. At the same time as they cause climate change, humans are affected by it. Therefore, the causes, mechanisms, and effects of interactions between humans and other components of the earth's system are at the core of climate change research (Mauser, 2006).

Given the widespread professional adoption of the label Anthropocene, I use it throughout this thesis to refer to the many-faceted effects of human forces of negative, long-term change on our environments and the multiple actors within them in the broader context of designing sustainable futures. This comprises imaginative and speculative ways of thinking, placing and suggesting alternatives to destructive forces.

Sustainability is another human-centred concept to describe a long-term plan for dealing with the effects of global changes. There is no comprehensive and universal definition of sustainability as a human goal. The most commonly accepted definition of sustainable development, from the United Nations report *Our Common Future* (World Commission on Environment and Development [WCED], 1987), is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (p. 43).

14 The Anthropocene, Capitalocene and Plantationocene can be combined holistically to explore our realities. Haraway calls for a new era, the Chthulucene, that is needed to keep pace with the ongoing troubles, threats and realities. The Chthulucene addresses 'dynamic ongoing sym-chthonic' forces of which humans are one part (Haraway, 2015). In this era, we can do the only possible thing: cooperate and play with other species to allow multispecies assemblages to flourish, 'making kin' with others (Haraway, 2015, 2016). These human-made concepts of our time reflect the past, an awareness of our current realities and visions of possible futures.

Another important concept of sustainability is found in the 'three pillars' – economic prosperity, environmental quality and social equality (Elkington, 1998) – that are interconnected and were widely adopted following the 1992 Rio de Janeiro Summit. The three pillars can be used as the components of the 'triple bottom line' concept used by organisations to assess their impact on society. Over time, those concepts were refined into 17 Sustainable Development Goals (SDGs) by the United Nations that cover global challenges ranging from poverty and peace and justice to clearly environmental matters and outlining the urgent need for collaborative actions from all countries. The Stockholm Resilience Centre has rethought the SDGs with regard to food, showing the interrelations between the biosphere, society and economy (Rockström & Sukhdev, 2017).

Official definitions of sustainability from the United Nations have an explicit anthropocentric focus, emphasising social justice and human needs. The SDGs show that most sustainability goals have evolved with human living, working, economic pursuits, technological activities; they reflect a consistent prioritisation of the human. The reality of the 1.5° requirement and the alarming projections of the economic and social costs of inaction in solving global and critical environmental challenges (Millennium Ecosystem Assessment, 2005) force us to rethink anthropocentrically focussed framings and practices of sustainability. The resulting paradigm shift views sustainability as referring to the whole system, including nonhumans, rather than individual components that are only connected to human interests. Consequently, sustainability becomes a process towards shaping and supporting a world of ecological flourishing and human wellbeing connected to systems thinking instead of being delineated by fixed human-centric goals (Bagheri and Hjorth, 2007; Ehrenfeld and Hoffman, 2013; Holling, 2001). This new concept of sustainability motivates radical change in how human civilisation will transition in all spheres – technological, cultural and social – and at all levels: individual, organisational and relational (Geels, 2005; Loorbach, 2010).

After reviewing climate change and the Anthropocene, I found that I needed to pay attention to different time frames. First, the realities of climate change require transformations into sustainable futures in a short time. Second, as a geological era, the Anthropocene needs a large space-time perspective to examine our activities and their influence on our planet. For design, this means providing approaches that can address the urgent issue of climate change while considering multiple and broader systems within an appropriately long-term time frame. DfS offers radical approaches to addressing long-term sustainability. The following section reviews DfS from multiple perspectives in terms of addressing long-term sustainability.

2.1.2 Design for Sustainability

The environmental movement and changes in the sustainability concept have long affected design. Here, I introduce the development of sustainable design approaches and the current stage of design towards sustainable transitions that react to the new notion of sustainability

discussed in the previous section.

> There are professions more harmful than industrial design, but only a few... by creating whole new species of permanent garbage to clutter up the landscape and choosing materials and processes that pollute the air we breathe, designers have become a dangerous breed.... In this age of mass production when everything must be planned and designed, design has become the most powerful tool with which man shapes his tools and environments (and, by extension, society and himself). This demands high social and moral responsibility from the designers (Papanek, 1985, p. ix).

Victor Papanek (1971) is among the pioneers who called on designers to rethink their profession in light of the environmental movement that emerged in the West in the late 1960s and early 1970s. *Design for the Real World* is in many ways a design manifesto for sustainability. In brief, Papanek argues that we need rethink the role of design in our society and address its power to address ecological and social issues.

Tony Fry (2009, 2020) puts forward a view of design's role in improving society and the environment and believes that design can lead to a transformation for sustainable development by changing design itself and considering the notion of futuring. He uses 'defuturing' to address the essential things we need in the future instead of future things that could harm our environment. Further, Fry (2009) asks us to rethink sustainability and use 'sustain-ability' to address necessary abilities to lives and cultures.

Under the notion of defuturing, Fry (2009) describes design as a 'redirective practice', working to stop disastrous unsustainability and let the diversity of humanity be directed towards a more sustainable world with a suturing character. Moving to a sustainable future requires two types of actions for making connections. The first requires all unsustainable practices to change, including those that create unsustainable qualities and trajectories of maintaining the status quo. The second refers to applications, which means using newly redirected practices to change the status quo; this redirected status quo can then create sustainability in the economy, social structure and the cultural and political order. To support these actions, changing platforms and designing in time are two methods Fry (2009) cites as options in design-based action for sustainable change. Designing in time means that designers need to think of time and especially futures that can inform and redirect practices that are happening now. Changing the platform means that designers need to alter their approaches and practices concerning the social-technical system through which design may be able to facilitate more sustainable designs.

Fry (2020) is a new edition of his 2009 work, which he rebrands in the title and concept of defuturing to resonate with emerging phenomena like the Covid-19 pandemic. In this latest version (Fry, 2020) defines defuturing as follows:

> as a learnt act of critical deconstructive reading, [defuturing] is able to trigger an unmaking of the ground of thought and 'logic' of fabrication, form, utterance and image, upon which present worlds, and world-makings, stand. Defuturing effectively exposes the negation of world futures for us, and many of our unknowing non-human others. (p. 10)

With such relational thinking, which is 'a way of thought that is not based upon cause-effect relations but on correlative processes and structures, and as such draws on the correlative thinking of the ancient Chinese' (Fry, 2020, p. 11), design becomes a presentation of 'fields of effects' in our world instead of being focussed on a singular designed object and consistently engages with humans, nonhumans and the environment. Design is thus both artificial and natural and provides the ability of world-making to build care-centred relationships geared to sustain futuring between actions, ways of living and their effects on environment and nonhumans. This view concerning relationships between humans and nonhuman to facilitate what Fry calls sustain-ability challenges the notion that design is a tool locked into functionalism, determinism and consumerism.

The history of DfS is complex and challenging to frame holistically because of its broad theoretical and practical scope. Recently, Fabrizio Ceschin and Idil Gaziulusoy (2016) mapped out the different design approaches for sustainability (Figure 2.2). Cheschin and Gaziulusoy divide DfS into four levels over time and along the two axes of insular and systemic and technology and people. This refers to a transversal shift and series of related and in some instances overlapping interactions between the technical-centred and human-centred to the system-centred, which is accompanied by a shift from single products to complex systems. The four levels are the product, product-service system, spatio-social and socio-technical system levels. Their DfS evolutionary model, with its mapping across time, and the emergence and repositioning of the term sustainability also allow us to connect such developments to the changing nature of the contexts of design, environment and ecology and culture and technology.

A diverse set of approaches to sustainable design is also annotated along the model's timeline. In summary, sustainable design approaches have featured green design (Burall, 1991) and ecodesign (Boks and McAloone, 2009), followed by the densification of approaches in the current century, including emotionally durable design (Mugge, Schoormans and Schifferstein, 2005), design for sustainable behaviour (Bhamra, Lilley and Tang, 2011), cradle-to-cradle design (Bakker et al., 2010) and biomimicry design (Volstad and Boks, 2012) at the product innovation level. The main goal of these approaches is to reduce the environmental impact of individual products by changing materials for degradation or recycling, building up emotional attachment between products and users and mimicking nature at various levels from function to system. These approaches focus only on environmental issues and products and thus sometimes lack depth in addressing complex user behaviours and significant environmental benefits. In other words, these approaches may promote green consumerism and technological determinism but fail to deal with complex environmental-social-technical problems, relations and

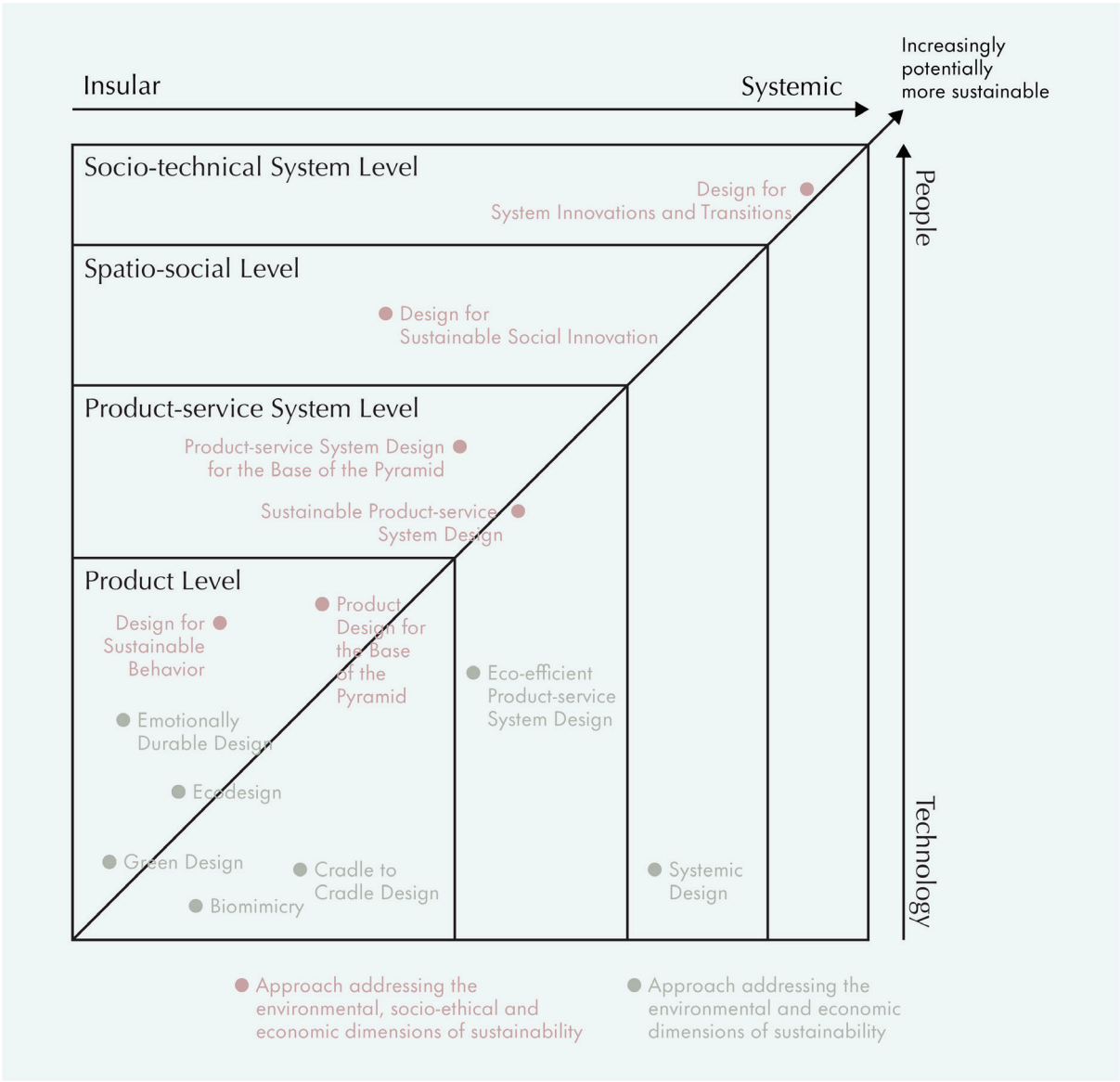


Figure 2.2 The DfS evolutionary framework (Ceschin and Gaziulusoy, 2016; redrawn)

possible futures.

At the product-service system level, product–service system design as a design approach to sustainability, is a product-service system that aspires to change production-consumption systems with a socio-ethical component of sustainability through business model innovation (Vezzoli, 2007; Vezzoli and Ceschin, 2011). The spatio-social system level also addresses system innovations with two approaches: design for social innovation[15] and systemic design[16]. The spatio-social level can place heavy emphasis on community but sometimes misses the importance of sociotechnical systems, while systemic design focuses on production systems, sometimes overlooking consumers' social behaviours.

At the socio-technical system innovation level, design for system innovations and transitions is an emerging approach focussed on the technological, social and institutional transformations of sociotechnical systems as a response to new sustainability demands. The design education programme at Carnegie Mellon University's School of Design has developed design education and research centred on what it calls transition design. In their article:

> Transition Design is distinct from service design or social innovation design in: (a) its deep grounding in future-oriented visions; (b) its transdisciplinary imperative; (c) its understanding of how to initiate and direct change within social and natural systems; and (d) its emphasis on the temporality of solutions – they have intentionally short or long lifespans. (Irwin, 2015, p. 237)

Transition design argues for the 'reconception of entire lifestyles' (Kossoff, Tonkinwise and Irwin, 2015), aiming to be location-based, participatory and harmonious with the natural environment and share information and technology globally. Wahl (2016) also addresses culture's role in this lifestyle transition and proposes a regenerative culture that is healthy, resilient and adaptable for humans; that is, ecological flourishing as a whole. Health includes both human and planetary wellbeing. Resilience and adaptability mean faster feedback through more immediately identifiable ecological limits and better solutions that can adapt to the unique conditions of a specific location. Resilience and adaptability address the importance of knowledge from traditional and Indigenous cultures, which take longer time frames into consideration[17].

15 Design for social innovation is a system of design practices aimed at innovations that are more likely to solve social problems and to do so effectively with lasting impact and easy diffusion (Manzini, 2014).

16 Systemic design geared towards systems seeks 'to create not just industrial products, but complex industrial systems. It aims to implement sustainable productive systems in which material and energy flows are designed so that waste from one productive process becomes input into other processes, preventing waste from being released into the environment." (Barbero and Toso, 2010, p. 68)

17 An example of Indigenous knowledge with contemporary values is offered by Azby Brown (2012), who argues that everyday life with an environmentally conscious, waste-free, well-designed living place, well-developed agriculture system and steady economic system in Japan in the late Edo period (1603–1868) can still teach and inspire us about sustainable lifestyle transitions like the 'just enough' lifestyle Brown elaborates. This regenerative culture is rooted in cooperation between the local and the global, Indigenous and modern knowledge and different agencies and actors.

From the perspective of a cooperative or regenerative culture, addressing cooperation between humans and nature, participatory and co-design approaches are suitable for use in an ecological design domain to heighten plural inputs and participation and the roles of stakeholders, including humans, nonhumans and the environment (Lindström and Ståhl, 2015; Rice, 2018; Smitheram and Joseph, 2020). Kristina Lindström and Åsa Ståhl (2015) combine actor-network theory and participatory design to build a participatory design approach embracing imagination, uncertainty and complexity. In this process, participation between humans and nonhumans in a co-designing process leads to generative 'figurations' (used to examine materiality and cultural imaginaries in feminist technoscience) to explore the question of 'what if?' and the emerging relationships entailed by that question. From a posthumanist viewpoint, participatory design can also become a place-practice-based process of making with the environment and engaging with nonhumans collaboratively through relational and non-anthropocentric thinking (Smitheram and Joseph, 2020). The role of nonhumans in a participatory design process can 'substitute' for and 'mediate' human action and communicate the design process (Rice, 2018). The notion of collaboration between humans and nonhumans from generative culture calls for a non-anthropocentric view of the ecological design approach for sustainability.

I now turn to ecological design related to sustainability. In my view, this is a mode of participatory ecological design. In one way, participatory ecological design means thinking about and practising eco-design. Design as a process incorporates laypeople and addresses the importance of local and organisational contexts to help society evolve towards a participatory and deliberative technology or 'strong precaution' (Howard, 2004). In other words, who participates and how they do so are increasingly being addressed in shifts to viewing design in more pluralistic ways (Escobar, 2018), including knowledge frames and conceptualisations of the environment and possible futures.

For environmentalists like David Orr (2004), ecological design is more than producing ecological products that preserve nature and the consumer economy; it is instead a matter of connecting science and culture to remake human presence in responsible communities. For Orr (2004),

> ecological design describes the ensemble of technologies and strategies by which societies use the natural world to construct culture and meet their needs. Because the natural world is continually modified by human actions, culture and ecology are shifting parts of an equation that can never be solved. Nor can there be one correct design strategy. (p. 14)

In this way, ecological design may be understood as a kind of awareness of daily life that aligns human conduct with ecology and allows humans to understand ecological potentials and constraints. Ecological design also becomes a synthesis, 'figuration' and assemblage of nature, culture and technology.

More recently, ecological design has been viewed as involving 'hyperobjects', to use Timothy Morton's term (2013). These hyperobjects are themselves materialised networks of new artificial creations and operate as an ecology of their own. This is an imaginative endeavour to address very real issues and creatively alters instrumentalised discoveries through the realisation of the awareness of uncertainty and complexity rather than projecting an idealised healthy ecosystem (Haraway, 2016). Ecological design, therefore, considers a new ecological culture that does not separate humans from nonhumans and views life as present in all material formations (Bennett, 2010). Kallipoliti (2018) defines ecological design[18] as working to address material, cultural and aesthetic issues from the Anthropocene and posthumanism.

These various design approaches indicate that sustainable design and design practice for sustainability may involve – and may need to include – diverse perspectives from the ecological system level to the individual level and from the global scale to daily life. These views all show the complexity of relations between the ecological, cultural and technical in sustainable futures to which we need to commit and secure and will need to continue to encounter in future design inquiry and making.

Design scholars have thus realised that we need to change design to care for our future survival and sustainable relationships with nonhumans and the environment. The design approaches reviewed above reveal the complexity and dynamic nature of design's response to that concern. Different researchers connect design with a range of disciplinary theories and aspects –technology-driven, systematic, posthumanist, cultural, social and future-focussed – to shape a design view on sustainability and ecology and build approaches that can contribute to specific fields, situations and scenarios. Taken together, the approaches are a good signal that the design is creatively caring about climate change, sustainability and anthropology. While climate change is still urgent and entangled with other issues such as the COVID-19 pandemic, more approaches will need to be developed into a dynamic design approach system to care for these issues in designerly ways.

For this research, I chose transition design as a starting point and connected transition design with speculative design to explore a relational design approach that cares about sustainability and ecology while considering more aspects. Next, I review speculative design.

2.2 Speculative Design

When discussing how to design, develop and secure sustainable futures, design needs to engage with how to work imaginatively by thinking ahead, anticipating and shaping to design

18 Kallipoliti (2018) divides ecological design history into three phases: naturalism (c. 1866–World War II), synthetic naturalism (c. 1966–2000) and dark naturalism (c. 2000–2017).

possible, potential and survivable futures (Fry, 2020). Our futures are a cultural fact, and they are always mediated through imagination and speculation (Appadurai, 2013), like Ramia Mazé and Johan Redström's project Switch! (2008). They used six practice-based speculative design research projects to explore alternative energy futures and argued that energy issues should be discussed through critical and ecological lenses. Further, the design-based speculation research Sensing Energy (Broms, Wangel and Andersson, 2017) challenges consumerism and capitalism and re-imagines everyday life through artefacts. The authors created a series of energy-related artefacts to critically imagine how we interact with energy and other resources in daily life and challenge the normal way of engaging with resources through new stories from people with the artefacts. In the following section, I review the speculative design from multiple perspectives that may help contribute to a future-oriented sustainable design approach.

2.2.1 Different Definitions of Speculative Design

(a)	(b)
affirmative	critical
problem solving	problem finding
design as process	design as medium
provides answers	asks questions
in the service of industry	in the service of society
for how the world is	for how the world could be
science fiction	social fiction
futures	parallel worlds
fictional functions	functional fictions
change the world to suit us	change us to suit the world
narratives of production	narratives of consumption
anti-art	applied art
research for design	research through design
applications	implications
design for production	design for debate
fun	satire
concept design	conceptual design
consumer	citizen
user	person
training	education
makes us buy	makes us think
innovation	provocation
ergonomics	rhetoric

Figure 2.3 Dunne and Raby's A/B Manifesto[19].

Speculative design can be traced from the design interaction programmes of London's Royal College of Art in the 1990s. Initially, speculative design appeared as a kind of critical design that focussed on 'going beyond optimisation to explore critical and aesthetic roles for

19 Available at: http://dunneandraby.co.uk/content/projects/476/0

electronic products; using estrangement to open the space between people and electronic products to discussion and criticism; designing alternative functions to draw attention to legal, cultural, and social rules; exploiting the unique narrative possibilities offered by electronic products; raising awareness of the electromagnetic qualities of our environment; and developing forms of engagement that avoid being didactic and utopian' (Dunne, 2005, p. 147). In this notion of critical design, designed artefacts and their processes become embodied critiques of consumer culture and encourage reflections on the norms, values and design practices of this culture, which can be viewed from Dunne and Raby's A/B Manifesto of Speculative Design (Figure 2.3). The A/B Manifesto provides speculative design with another dimension of design and addresses the importance of questioning our contemporary challenges through narratives of futures. The A/B Manifesto reveals a new design practice-research model to cooperate with industry and academic institutions to ask different questions and revisit problems through design artefacts and their social fictions.

Further, Dunne and Raby (2013) regard their critical and speculative design practices as critiques of design itself and propose a cultural-social reality that 'thrives on imagination and aims to open up new perspectives on what are sometimes called wicked problems, to create spaces for discussion and debate about alternative ways of being, and to inspire and encourage people's imaginations to flow freely' (p. 2). Beyond the speculative design role of critiques, Disalvo and Lukens (2009) argue for the importance of speculative design processes:

> Within the context of technology goods and services, speculative design can be defined as the deliberate configuration of technological systems to explore future-oriented scenarios, conditions or consequences of technology use... such interactions and experiences suggest the potential of extending the range of engagement with and effect of speculative design beyond the common audiences of other designers and critics. (p. 2)

Speculative design plays a critiquing role through its outcomes and engagement with others, various disciplines (especially science and technology), and a range of stakeholders through different format design activities. Speculative design processes have the advantage of imagining alternative futures of science and technology through design skills, as Ginsberg (2010) comments: 'Design can engage with science and technology in new ways, bringing the designer's skills of functionality, synthesis, collaboration and tangibility to allow us – biotech's ultimate consumers – better access to question and consider alternative futures' (p. 266).

As to outcome and process, speculative design is a kind of research approach or investigative tool to explore future technologies and science from multiple non-commercial perspectives through different design prototypes. A more detailed description of speculative design as an approach is offered by James Auger (2012):

> First, through informed extrapolations of existing product lineages, 'speculative futures' imagine and present near-future products, systems and services. These are intended to act like a cultural litmus paper, testing and examining the implications of an emerging technology before we commit to specific applications or research

directions.

> Second, 'alternative presents' are speculative design proposals that question existing paradigms through the design of products and services that utilise contemporary technology but crucially apply different ideologies to those currently directing product development. These speculations on how things could be, had different choices made in previous times, and are used to examine the values of contemporary products. (p. 29)

Speculative design and critical design both strive to open up places for discussion and imagination around the uses, misuses and possible effects of technology on society and culture through 'fictional worlds, cautionary tales, what-if scenarios, thought experiments, counterfactuals, reductio ad absurdum experiments, prefigurative futures, and so on' (Dunne and Raby, 2013, p. 3).The speculative design perspective from the Royal College of Art has firm roots in critical design. Some researchers believe that critical design is best viewed as a sort of quasi-art or a form of design entertainment enjoyed for its humour or novelty rather than for its insights (Malpass, 2017).

In the industrial design domain, Malpass (2017) divides critical design into three categories: speculative design, associative design and critical design. For Malpass, speculative design is 'concerned with the projection of sociotechnical trends, developing scenarios of product roles in new use contexts. It makes scientific theories and the cultural implications of science perceptible in different ways and shows them in everyday contexts'. Malpass's (2015) understanding addresses the capacity of speculative design to communicate a narrative or 'rhetorical function' through the combination of media to build up designed objects and those objects' context. This means speculative design offers more materials for the audience to understand this developing fictional design in the familiar context of everyday life.

2.2.2 Demarcating Knowledge Through Speculative Design

The rhetorical role of speculative design appears along with and within several areas of design. Some new notions of design like discursive design and design fiction have been introduced by fiction writer Bruce Sterling. Overall, they may be viewed as related perspectives on design, imaginaries and futures that offer designers and design researchers a kind of 'cultural litmus paper' through which to conceptualise and analyse relations between design, speculation, futures and presents.

Design fiction refers to design works that depict alternative futures of design and its world through imagination and speculation. As a theoretical and artistic approach, it can support past, present and future research (Hales, 2013). During an interview, Sterling provided a definition of design fiction:

> The deliberate use of diegetic prototypes to suspend disbelief about change. That's the best definition we've come up with. The important word there is diegetic. It means you're thinking very seriously about potential

> objects and services and trying to get people to concentrate on those rather than entire worlds or political trends or geopolitical strategies. It's not a kind of fiction. It's a kind of design. It tells worlds rather than stories. (Bosch, 2012)

In design fiction, there are two crucial focuses around designed objects: 'world building', which concerns contextual settings, and personas, which concern object design settings. World building in design fiction involves collections of artefacts that build up a fictional world with a unique view and emphasise the world's cohesiveness and interactions between humans and things in that world (Coulton et al., 2017). In other words, the collection of artefacts can serve as a world or platform for design, and design can also define the platform. The fictional world of design can be a space to explore in different ways, and the trajectories of exploration are diverse. Inside the fictional world, designers can combine their personal histories with design processes (e.g., field studies, prototyping and exhibiting) to build up a fictitious persona to address the wicked problems of climate change and the Anthropocene (Morrison and Chisin, 2017). A speculative persona can be emotional and embody designers' psychological responses to show attitudes and different imagined actions in a collaborative vision for big-picture issues instead of specific everyday problems. In these cases, a design fiction persona becomes a partner in world making.

Methods connected to design fiction and speculative making and analysis have also been developed. Markussen and Knutz (2013) address the link between literary practice and design practice and use poetic techniques to develop methods and a typology for design fiction. Their four-step method are writing contextual scenarios, developing basic rules of fiction, experimental process of world-making by drawing and building and prototyping design fiction. They also identify five aspects though which to analyse design fiction: what-if scenarios as the basic principle of construing design fiction, the manifestation of critique, design aims, materialisations and forms and the aesthetic of design fictions (p. 9). These five aspects demonstrate design fiction's basic role, critical content, possible consequences, presentation form and political perspective. Markussen and Knutz argue that design fiction can be a more humanities-driven design research methodology through the use of individuals' critical and aesthetic capacities. This view of design fiction addresses the role of literature in design. Design not only facilitates functions and solves problems but is a medium for communicating ideas, for critique and to understand problems.

This focus on media, design and cultural communication has been taken up in discursive design, which, according to Andrew Morrison and colleagues (2011), is the process of making, critically analysing and communicating design artefacts with a broader perspective on design critiques and narratives:

> Discursive Design is at the same time dynamic and transformational. Yet it is speculative and communicative. It moves out of the lab, field and gallery and into design spaces and spaces for design experimentation. This is something that matters for engaging with new tools and technologies and their impact on our practices and

> analysis. (p. 4)

Based on the notion of discursive design in Scandinavia, Bruce Tharp and Stephanie Tharp (2019) developed a version of discursive design in which the

> primary agenda is to convey ideas. Discursive design is presented as analogous to a genus, which comprises various species such as critical design, speculative design, and design fiction. Discursive design asks its audience to take an anthropological gaze and seek understanding of its artefacts beyond basic form and utility. (p. 5)

Tharp and Tharp (2019) propose a form of discursive design rooted in rhetorical, semiotic, sociocultural and critical traditions, including design approaches that do not focus on functionality and problem-solving. They list many design techniques and projects around design artefacts to demonstrate what discursive design can include.

Considering the rhetorical, critical and fictional characteristics in design, 'critical play' and 'serious play' have been taken up in new game design to challenge and examine social, cultural, politically popular and mainstream play space reality (Flanagan, 2009; Tronstad, 2010). Flanagan (2009) defines critical play as an effort 'to create or occupy play environments and activities that represent one or more questions about aspects of human life. These questions can be abstract, such as rethinking cooperation, or winning, or losing; or concrete, involved with content issues' (p. 6). Criticality in play adopts an analytical frame or viewpoint to rethink the setting of necessary play scenarios. The core approach of critical play is to design subversions of game mechanisms and systems, which allows players to experience alternative game scenarios and raise questions. The challenge of serious play is to make the play both serious and compelling, requiring creative designers to embrace and critical complexity to create subversive games (Tronstad, 2010). Critical play can be used as an approach to experiment with subversive systems for making alternatives and critically analysing our real world and those alternatives.

Compared with critical play, Maja Kuzmanovic and Nik Gaffney work with physical artefacts focusing on transmedia (2017) to offer a transdisciplinary and embodied method of speculative inquiry about experiential fabric futures in everyday life. Audiences can directly experience such futures:

> Experiential futures could be seen as a foresight-centric response to future preparedness. It is an attempt to bring the worlds of tomorrow into the present in a way that can be experienced directly. In the absence of functional time-travel, such attempts rely on more mundane techniques borrowed from theatre, design or psychology, including speculative artefacts, videos, interactive installations, games or 'guerrilla' interventions in public spaces. (p. 110)

Their installation offers a situated interaction involving both the minds and bodies of audiences by connecting 'rational analysis', 'abstract speculation', and 'embodied knowing'. This also combines uncertainty with preferred futures through these multiple ways of experiencing and knowing and triggers future beneficial actions. For Kuzmanovic and Gaffney, speculative design is a research method for asking questions and making new connections instead of reaching a specific research outcome.

Beyond the design discipline, scholars from other fields have attempted to conduct research on speculation itself as a process of knowing and to develop alternative approaches that address the values of futures in contemporary inquiry (Savransky, Wilkie and Rosengarten, 2017). These authors regard speculative research as a collective and transdisciplinary activity that involves new forms of attention, invention and experimentation. The most important outcome of speculative research is its proposition, which can lead us to sense the importance of alternative lives through the amplification of our feelings (Michael, 2017). Compared with forms of speculation outside design, tangible forms can be an interesting area for different disciplines and the public. Consequently, researchers from the social sciences have increasingly cooperated with designers to carry out speculative research in which design is regarded in aesthetic and creative terms. In the social sciences, speculation can be understood as a constructivist approach that 'concerns the fabrication of concepts and explanations as well as the devices, techniques, practices that partake in the milieu of the research event' (Wilkie, 2018). If we understand speculation in this way, then there are three consequences:

> First, to take seriously the historicity and specificity of phenomena under study; second, to include the becoming of the practices, concepts and technologies which give rise to that which participates in the research event; and, third, the upshot of the research event is a matter of practical investigation rather than the preserve of philosophical thought. On this last score, the act of speculating, understood as the engagement with the unfolding nature of 'social' or 'cultural' phenomena (which are necessarily heterogeneous), is also a practical matter of investigation. (p. 349)

Speculative research is discussed from historical and cultural perspectives. Speculative design thus occurs within a cultural-techno system. In this sense, it explores the potential and problems of technology and culture simultaneously through creative making, making for new history and materialisation.

This section does not aim to classify speculative design and research or to fully contextualise speculative design from a historical perspective. Rather, it seeks to offer a holistic view of speculative design and its research outcomes to build up a dynamic and pluralistic view of this developing field. In the next section, I discuss the critiques of speculative design and its potential for my research.

2.2.3 Potential and Critiques

In light of the concepts of transition design and ecological design described in previous sections, speculative design has been critiqued on two counts. First, it can be seen as a kind of culturally colonial and patriarchal privilege (Martins and Oliveira, 2014); speculative design practice and education are characterised as usually happening at prestigious schools in the Global North. The context and view of its practice are thus narrow. From my perspective, the current situation lacks plural views from the Global South to critique our reality and anticipate possible futures. Most speculative designs read different cultures through a Western lens – many students from the Global South study speculative design in Western schools, and speculative design is still a comparatively young design area with a lack of diverse cases. It may take a long time to build up a space for design projects from plural cultural perspectives on grand challenges like climate change. Such a diverse and creative yet critical space could also be a way to prevent a closed nationalism that exacerbates East-West dualism. In this regard, we also need to develop activities and outcomes of shared knowing by analysing and sharing speculative plural futures.

Second, speculative design does not address potential structural problems that must be considered to change social-technical systems for radically different sustainable futures (Tonkinwise, 2015; Ward, 2021). Further, speculative design is sometimes viewed as gallery work with specific aesthetics to show dystopian scenarios rather than addressing solutions that will transform our everyday lives through new materialisations. These critiques can also be seen from the perspective of 're-directing' the practice of design (Fry, 2009) so that future-oriented design discusses 'what if?' and explores 'how else?' Some speculative design projects, such as those by Alexandra Daisy Ginsberg and Neri Oxman, have involved cooperating with scientists to investigate the 'how' question that emerges after 'what if' has been answered.

Faced with these two critiques of speculative design, my research adopts speculative inquiry with relational thinking as its main methodology. I adopt insights from posthumanist relational ontology to revise speculative design with nondualist and non-anthropocentric views concerning these critiques by creating and analysing relationships through design that arise from simultaneous diverse speculations.

Over the last two decades, beyond speculative design, futures studies and design have broadened their scope to address and assess a wide range of issues, including field, method, complexity, emergence, pressure and global uncertainty. There have been suggestions to call research related to futures 'futures studies' rather than terms 'futurology' and 'foresight'. Futures emphasise plurality and diversity that include the Global North and the Global South and the positive and the negative, thus embracing the exploration and discussion of all possibilities. The design field has also sought to make design-related futures more plural. Elliot Montgomery has developed an ongoing mapping of speculative design (Figure 2.4) based on survey responses

from members of the design community who work closely with design practice and future-related research. This is intended to show that speculative design can play different roles and can be adapted for use with diverse strategies.

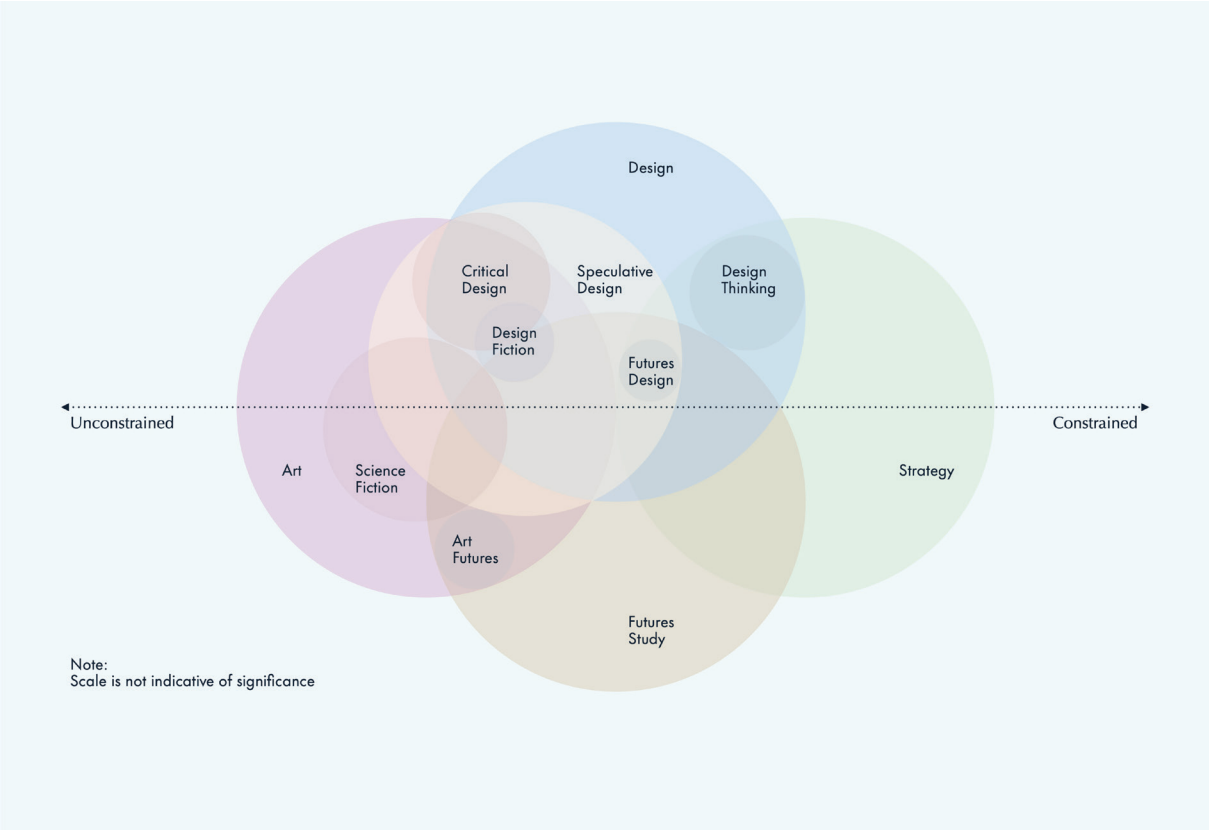


Figure 2.4 Redrawn from 'An Unresolved Mapping of Speculative Design V2.0', Elliott Montgomery[20], (Zou, 2021).

The account above indicates that speculative design is an open perspective across disciplines ranging from art to management, thus creating and positioning a 'speculative culture', to used Sterling's term (2009). Sterling points to speculation skills, such as futurist scenario work, storyboards, storytelling, brainstorming and mashups. These can be found in business activities and start-up cultures. They are also part of design fiction into contexts and futures shaped by design. Design futures, as an ongoing design research theme, will have more approaches to address different views. Next, I introduce another design futures approach: anticipatory design.

20 Available at: https://www.epmid.com/projects/Mapping-Speculative-Design.

Anticipatory design addresses both the cultural and speculative aspects of design. Celi and Morrison (2017) provide the following overview of anticipatory design:

> Anticipation may be shaped as a future pursuit, informed through Design and supported by way of linkages with Futures Studies that are equally polymorphous and conjectural alongside other much needed procedural, fictive, and necessary foundations upon which to aspire, approximate, propel, and together project designs fictions and future-oriented inquiries. (p. 22)

Anticipatory design addresses future thinking ontologies in the materialisation of artefacts and the processes of that materialisation, generating cultural knowledge through making and co-creativity. This approach can construct futures through an exploratory, anticipatory, critical and cultural process for imagined, disruptive and transformative strategies in the context of the Anthropocene.

The concepts of design reviewed in this section address cultural aspects of futures and the contexts of everyday life. These concepts show that speculative design artefacts can play many innovative roles as designed products. This relational ontology sets up critical, discursive, playful and experienced characters that can be used to analyse and recognise artefacts' potentials, effects and contexts. This is a change from product design focussed on use, function and system to one concentrating on communication, effects and atmospheres. The relationships between sustainable design and speculative design and combinations of the two from the perspective of everyday imaginary Life Styles are elaborated in Publication 1.

In the next section, I detail the concept of Life Style and its related concept of Life Form to explain why I chose them as the main research field and analytical frame, respectively.

2.3 Life Style and Life Form

My thesis examines speculative design as a means of exploring the imaginative and its contribution to long-term sustainability. The context in which I place that work is looking at Life Styles and Life Forms as part of the relationship between design and culture. Generally, I use Life Style to refer to assemblages of value, identity and designed objects that maintain the value, identity and context of a given cultural spaces. By Life Form, I generally mean the special form of each object. In this next subsection, I elaborate on these two themes and connect them to long-term futures and the links between transition and speculative design.

2.3.1 On Life Style

The definition of lifestyle varies in different fields, cultures and languages. In Chinese, lifestyle expression can be described as 风尚, which refers to prosocial behaviours or a positive way of living in a given period. Its Latin expression, *modus vivendi* translates to 'way of living' and encompasses values and attitudes. My motivation is to keep an open mind on cultural

perspectives when investigating everyday life and social transformation, sustainability and speculation and connecting Life Style concepts with relational thinking.

Sociologists have traditionally regarded lifestyles as the amalgam of an individual's life choices and expectations (Pulkkinen and Kokko, 2000). In studies of consumer culture, Life Style can be distinguished by items consumed or consumption patterns (Connolly and Prothero, 2003). These two concepts have been used to study individuals or groups, and the scope of their objects can change, which complicates my definition of Life Style, which is an integrated concept formed by personal, community and larger groups.

For individuals, Life Style will be analysed as everyday practices when facing different realities. These Life Styles express and change with individuals' personality and identity development and will also be affected by other individuals and groups. Giddens (1991) characterises these phenomena as follows:

> A lifestyle can be defined as a more or less integrated set of practices which an individual embraces, not only because such practices fulfil utilitarian needs, but because they give material form to a particular narrative of self-identity. (p. 81)

Life Style can also be understood as a material expression of personal identity (Wilska, 2002). It incorporates the material practices of everyday life to explore different social and symbolic values. In the discipline of psychology, Life Style at the individual level shares elements of George Kelly's personal construct theory (1963) and as a system that determines and evaluates an individual's actions (Reynolds and Darden, 1974; Veal, 1993). On the individual level, Life Style is the way of living expressed by an individual under the influence of values, identity and effects in a symbolic, social and cultural space.

The earliest focus on the group level of Life Style can be traced back to Max Weber's style of life. Weber regards style of life as how a group's status strengths the boundaries of its social classes (1948). Under capitalism, Life Style also shows the economic capabilities and social power of different classes (Bourdieu, 1986). In the 1960s, lifestyle became a market research tool, which can be seen as an extension of the concept of Life Style as a class, classifying the market through different social classes and observing the consumption habits of those classes. Using lifestyle as a market research tool has been questioned because it is too general to support the development of specific products (Beatty et al., 1985). As a consumption pattern, lifestyle has also been critiqued as a tool of manipulation, domination, division and exploitation in consumer society by providing a free space for consumers to fashion their own lifestyles and self-identities (Tomlinson, 2010).

One of the core issues for consumer-based Life Styles and gratifications is the model of continued growth, which has profound consequences for climate change. Stoddard et al. (2021) are

most clear about how three decades of attempts to mitigate climate change have not reduced the levels of emissions needed to avert the climate crisis. Changing attitudes and behaviours may be needed to effect such change, but sustainable futures cannot be secured without changing underlying economic models, notably the promotion of endless consumption. At the same time, Life Styles will need to be dynamic and engage consumers, policymakers and the public to look differently at and rethink relations between the environment and satisfaction. Speculative design may be used to offer alternative Life Styles that include surprising and engaging ways of rebuilding the relations between humans, nonhumans and ecology.

Contrary to the prevailing consumerist culture, Life Styles in subcultures mainly discuss cultural-social differentiation. These differentiations can be analysed by groups of actors and their social status and cultural styles, including thoughts and actions shared by the members of these groups. Berzano and Genova (2015) proposed a new view of lifestyle as integrated with subculture and a tool to analyse how different interactions in specific lifestyles actually create these and present these lifestyles. My concept of Life Style can be viewed as a space with values, identities and behaviours formed by the interactions between individuals who can vary in number. Beyond this focus on individual Life Style and everyday life, 'lifestyle movements' cover potential collective actions and activism through network building (Fuist, Mogford and Das, 2018). Individuals with specific Life Styles often have similar ideologies and everyday routines. These same identities and routines allow individuals with similar Life Styles to attend the same events and activities and make connections that have the potential to stimulate personal actions and participation in collective social movements.

In the postmodern era, value, affect, desire and identity have become the centre of Life Style in contemporary cultural studies (Johansson, 1994). In this thesis, Life Styles are analysed through conceptualising values, including immaterial or digital dimensions, individual choices and the interactions between everyday life and media concerning popular events. Life Style thus becomes a symbolic space influenced by complex mechanisms that allow everyone to create their own stories and a way to describe or analyse the relationships between individuals and social and cultural structures.

Jensen (2007) proposed using lifestyle as a neutral research tool for sustainability and divides lifestyle into four levels to study sustainability: global, structural or national, positional or subcultural and individual. In my research, Life Style at the global level is a kind of expression of a worldwide consumption class influenced by the availability of products and the amount consumed. Life Style at the structural or national level is a regional collection of actions and expressions that governments can influence by distinguishing one area from another while also uniting their citizens. Life Style at the positional or subcultural level visually expresses a group consensus routine and connections affected by different social classes, status classes, ethnicities, generations and various forms of movements and networks. At the individual level,

Life Style is a form of self-identity, and consumption is used to maintain this identity. At this level, Life Style is also a pattern of repetitive actions involving the use of artefacts and a set of habits directed towards the same main goal. In other words, Life Style at the individual level is influenced by social feedback and artefacts.

These four levels of Life Style that I have adapted from Jenkins demonstrate that different projects need to use different Life Style tools. For example, it is better to research carbon-related Life Styles at the global and national levels. For design, Life Style is focussed on the individual and subcultural levels. Concepts of design can express social values and identities of sustainability, and designed artefacts can demonstrate those values and identities.

The Life Style concepts presented above differ from what is generally considered a particular way of characterising lives in the context of consumerism. Life Style here is more involved in matters of the particularity of our daily lives, consumption models, interactions between people, social movements and different cultures, regions and countries. In Chapter 5, I elaborate on my understanding of Life Style as a designer from a speculative and relational viewpoint.

2.3.2 Sustainable Life Style Against Consumerism and Design for Wellbeing

Consumerism is an enormous challenge for climate change and can be critiqued as a consequence of capitalism (Klein, 2015). By constructing standards and marketing freedom to consume symbolised products, people are driven to work more and achieve a desired standard satisfaction in life beyond basic or real needs and focusing instead on individual or collective benefits (Cutts, 2019; Marcuse, 1964). In this capitalist trap or market-driven social control, people consume products for economic growth, sustenance and pleasure. Yet, the basic principle is to be encouraged to work more to buy more things. Consumerism thus shapes identity and specific Life Styles that further encourage people to buy more things to construct a social and economic development model (Campbell, 1987). In this consumerist model, products have increasingly become designed to encourage insatiable desire (Schor, 2004) and disposal (Morgan and Birtwistle, 2009) while ignoring the environmental damage from consumerism, such as the fast fashion industry and other low-cost retailers. Consumerism also expands the design niche to develop more kinds of products that can provide more symbolic possible products to promote more consumption (Julier, 2017). Products are designed for sales rather than for real human needs.

Some emerging concepts counter to consumerism like degrowth (Kallis, Demaria and D'Alisa, 2014; Kallis et al., 2020) call for an alternative to how we produce and consume in the material world, advocating for a shift from focusing on economic growth to new resilient values and institutions of sharing towards wellbeing that involve new relationships between humans. A sharing model of consumption can distribute resources to achieve sufficiency of usage and obtain a quality of life with limited resources. In this model, the economy will grow slowly

but reduce its overreliance on resources for growth, unlike the current economic models that emphasise growth, individual ownership and efficiency. In the atmosphere of a market-driven world, a capitalist standard predominates. It has been difficult to imagine an alternative society through design since design's tradition is to work closely with the market (Julier, 2017). This is why many sustainable design approaches call for a future-oriented view that could feature, for example, sharing and degrowth.

Sustainable Life Styles are expanding globally. At the national level, a sustainable Life Style developed in Japan is called the Fourth Consumption Society (Atsushi, 2014) and boomed after the 2011 Great East Japan Earthquake. At the individual and subcultural levels, Americans have begun to want to live low-carbon Life Styles. Many of them used 'plenitudinous' as a slogan and have tried to reduce their energy use (Schor and Thompson, 2014). Having fewer hours of paid work as a principle, they put more significant investments in the community and have used high-tech services for themselves[21].

Sustainable Life Styles are closely related to the aims of human wellbeing like those spelled out in the SDGs. Sustainable Life Style concerns human wellbeing or quality of life, which focuses on human needs and life aspirations while considering ecological welfare at the same time. Value-sensitive design (Brey, 2015; Friedman et al., 2013) argues that wellbeing as a key value should be considered in the design process to create artefacts that conform with or promote wellbeing. In the sustainability and design section above, I have elaborated on the design approach towards ecological welfare. I now turn to some further design approaches towards wellbeing.

Positive design (Desmet and Pohlmeyer, 2013)[22] concerns design for subjective wellbeing concerning positive affect, including moods and emotions, and a meaningful life as judged by cognitive satisfaction. Subjective wellbeing is not like objective wellbeing calculated by resources like food, water, housing and work. Patrick Jordan (2000) argues that emotional design[23] focuses on four kinds of pleasure that can enhance wellbeing: physio-pleasure, which is bodily pleasure derived from the sensory organs (pleasurable sensory design features); psycho-pleasure

21 They have created local food economies, combined with farmers' markets, community-supported agriculture, urban agriculture, seasonal eating and farm-to-table restaurant culture. Working through one-on-one actions, people are now living very different consuming Life Styles. They save money, create more social bonds and reduce their ecological footprints.

22 The method of positive design is to facilitate pleasure activities for positive feelings (relaxing/fun/living problem-free), build up (long-term or short-term) personal meaning (awareness of achievements and the feeling of making progress towards a long-term aim) and ensure virtuous behaviour through design. These three methods can be launched separately for individual wellbeing and can work together for ecological welfare.

23 Emotional design can provoke pleasure through design artefacts with pleasurable sensory design features, good usability and features that express socio-cultural identities and material or semiotic features that express values. Norman (2005) offers a broader view of emotional design. For him, it employs artefacts to enhance wellbeing through their appearance (visceral level), their usability and functional and tactile features (behavioural level) and their material and semiotic features, which can demonstrate personal, social and cultural significance (reflective level).

derived from cognitive and emotional reactions (usability); socio-pleasure arising from social activities with others; and ideo-pleasure from personal (aesthetic, moral and cultural) values and personal aspirations.

There are wellbeing designs that not only focus on socio-cultural contexts but also investigate the role that technology can play in wellbeing design. In contrast to design for positive feelings, capability approaches to design (Oosterlaken, 2009; van den Hoven, 2012) focus on strengthening basic human capabilities to improve quality of life[24]. The goal is to increase and extend one or more essential human capacities through new technology design while avoiding damage to other capabilities. Beyond the narrow use of technology, Leikas (2009) came up with life-based design which connects humans' entire lives with technologies. There are four steps in conducting life-based design (Leikas et al., 2013): form of life analysis, concept design and design requirements, fit-for-life design and innovation design.

All these approaches to wellbeing design are practical ways for designers to consider human health and potential as a whole. At the same time, the obvious weakness of these approaches is that they are human-centric, which presents a narrow framework for identifying and working with wellbeing in the Anthropocene. Another weakness is that they focus only on improving Life Styles within a capitalist world through technology and ignore the uncertainties and potentials of technology that could not only change Life Styles but also Life Forms. I turn to the concept of Life Form in the next section.

2.3.3 On Life Forms

In this thesis I take up the notion of Life Forms to focus on relations between a diversity of entities in the context of climate, futures and sustainability. These entities include humans and nonhumans in dynamic relations that range from the biological to the technical. Defining life is sometimes ineffective because the world in which we live is much larger than the world we know (Machery, 2012). Life form is an artificial concept most often defined by the biological sciences (Cleland and Chyba, 2010). These life forms are similar because they are all based on biochemical complexes. In earlier times age, life was seen as a system that could evolve through natural selection (Sagan, 1970). Today, AI can also be seen as life, whether from a philosophical view such as animist design (Marenko and van Allen, 2016) or a scientific view that life is based on bits of information instead of DNA codons (Carroll, 2009). Generally, a living creature is any autonomous system with open-ended evolutionary potential (Ruiz-Mirazo, Peretó and Moreno, 2004). I use this definition of Life Form, which is found in astrobiology, AI and the study of the origin of the earth. In this view, nature and culture together shape the formational

24 Capability approaches to design may have difficulty considering the context in which capabilities are used for wellbeing since capabilities cannot calculate pleasure from social and cultural values (Murphy and Gardoni, 2012). This could be seen as a form of technology determinism.

processes of the materialisation of life; they contribute to a new Life Form with cultural and biological attributes.

Stefan Helmreich and Sophia Roosth (2016) argue that life form has evolved into a future-oriented and constructive approach to vitality. They divide the life form concept into three stages: deduction, induction and abduction. In the deduction stage, the meaning of life form relates to accuracy and geometrical discipline in life after studying various living forms in their entirety. In the induction stage, life form takes shape in connection to several types of causal ontologies or fields of possibility, whether recognised as species or grouped into kinds occupying regions of physical, metabolic or ecological possibilities. In the abduction stage, life form seeks to broaden biological theory to augment explanations of living forms by situating such accounts in universalism, which has been broadened to embrace purely speculative and even fictional cases.

From an AI perspective, my view of Life Form holds that formal and material attributes may be advantageously partitioned and that form is all that counts (Kelly, 1991). From a science fiction perspective, the use of life form mixes aesthetic and morphological meanings with ideas of life materialising in the physical realms of potential (Helmreich and Roosth, 2016, p. 33). With these multiple meanings, Life Form can be viewed as an elastic term, a working frame and a 'capacious doctrine' (Empson, 1948), with a constitutive incompleteness that is ready to be applied to new challenges (Empson, 1948; Helmreich and Roosth, 2016). Referring to Empson, Helmreich and Roosth (2016) have provided an overview of the life form concept and suggest that '"life form" has moved from its origins as a term referring to abstract, idealised, aesthetic possibilities through reference to biogeographic and evolutionary possibilities to, today, conjectural and future possibilities' (p. 20).

When the Life Form concept is expanded, two things need to be discussed for humans to address a sustainable Eco-Cultural-Techno system: artificial Life Forms and the new concept of human. Lorraine Daston and Peter Galison (2007) speculate that science is a mode of presentation rather than representation in which 'making and seeing are indistinguishable' functions (p. 46). In this scientific presentation era, artificial Life Forms like synthetic biology and AI show how technology shapes the way we understand and intervene in the natural world. The world is iteratively integrated into production activities. When life can be created, transformed, reformed and deformed, the relationship between making and knowing is radically reconfigured. This reconfiguration changes how we think about nature and culture and how we analyse and synthesise. Synthetic biology is descriptive and analytic, natural and cultural and has used the concept of social life forms to discuss 'design and creation, kinship and relatedness, property and exchange, labour and economy, expertise and political action, novelty and species' (Roosth, 2017, p. 177).

Furthermore, artificial life is performative in that its form takes precedence over its content (Helmreich, 1998). Artificial life can be made from any material and thus reveal qualities we cannot anticipate. This idea contrasts with the historical concept of life, which depends on realistic animacy and prioritises biological substance over biological form.

Our Life Form is changing through different physical, biological and digital enhancements. Our enhanced Life Form is damaging the planet's climate and natural resources and has rendered ineffective the various social, political and economic efforts to change Life Styles in ways that are commensurate with the enormity of the crisis (Nixon, 2011). In this context, however, culture and nature exist in a coevolutionary relationship. This relationship can be seen in contemporary scientific discoveries in which bodies constructed and recomposed through time are shaped by culture, symbolic forms of communication and 'imaginative anticipation' (Frost, 2016; McEwen, 2012; Slavich and Cole, 2013). In this regard, Samantha Frost (2016) has demarcated humans as biocultural creatures to account for the biological, environmental and cultural forms of human life:

> To consider humans as biocultural creatures is to have a basis for thinking about humans as political subjects without recapitulating the forms of human exceptionalism that have relied on a disavowal of materiality, embodiment, animality, or dependence. (p. 177)

The sections below on Life Style and Life Form show the development of the two concepts. Life Style is entangled with subculture, digital media and more postmodern cultural productions to strengthen the role of social value and self-identity in research. From the posthumanist and relational viewpoints, Life Form results from the coevolution of nature and culture and can be changed by technology. Life Styles and Life Forms interact within ecological, cultural and technological systems. I review the relationships between ecology, culture and technology in the next section.

2.3.4 Relationships Between Ecology, Culture and Technology

The concepts of Life Style and Life Form reveal that we live in a hybrid world with nature, culture and technology, not a dualistic one. The concept of Life Style addresses the cultural importance of sustainability. Design for sustainable Life Styles that address wellbeing and the concept of Life Form raise a question about the role of technology in our world. In taking this up, this section elaborates on the relationships between ecology and culture, technology and culture and technology and ecology to show the potentials of an Eco-Cultural-Techno view through Life Style and Life Form.

2.3.4.1 On a Three Ecologies Perspective

In *The Three Ecologies*, Guattari (2000) integrates multiplied difference and creative autonomy with a view on ecosophy to rebuild and refresh humanity's belief in the ability to reconstruct social and individual ecosophical practices when confronting ecological disequilibrium. He

claims that ecosophy allows for an ethico-political and ethico-aesthetic articulation in three ecologies: nature (environmental), social connections (social) and human subjectivity (mental). As a whole, these three ecologies, as 'interchangeable lenses' or 'styles', are produced relationally and transversally to constitute a space of negotiation and reconstruction rather than different territories.

Guattari's three ecologies can be summarised as follows. 1) Environmental ecology is broad and may include country, cosmos and even human-made techno creatures and their environment. 2) Social ecology focuses on the group level by considering effective and functional development in human groups of different sizes; this ecology includes reorganisations related to mental ecology, favouring processual semiotics, post-media and de-territorialising family, assemblages and religious groups. 3) Mental ecology focuses on the individual level and includes individual psychology, innovative practices, experiences of singularity and productions of autonomous subjectivity. Guattari writes at the end of this publication that

> rather than remaining subject, in periphery, to the seductive efficiency of economy competition, we must reappropriate Universes of value, so that processes of singularisation can rediscover their consistency. We need new social and aesthetic practices, new practices of the Self in relation to the other, to the foreign, the strange – a whole programme that seems far removed from current concerns. And yet, ultimately, we will only escape from the major crises of our era through the articulation of
> - A nascent subjectivity
> - A constantly mutating socius
> - An environment in the process of being reinvented. (2000, p. 45)

According to Guattari, subjectification and singularisation should be fostered and exemplified by the logic of ecosophy. Individual and collective subjectivity may amount to creative expression without collective goals. Individuals, organisations and professions will grow more unified while becoming more diverse and creatively independent as a result of continuous resingularisation. The three-part perspective offers references for creative practices that bridge the three ecologies through a critical, relational and transdisciplinary approach to resolving ecological issues.

Martin Ávila, following Guattari's three ecologies, shifts design frames and models of ecological design from a human-centred to a non-anthropocentric view. The 3Ecologies model built by Ávila and colleagues is used to analyse design through individual activities, social relationships and local environmental costs and benefits, which could address more factors, including Life Styles, ethical issues and concerns about globalisation (Ávila, Carpenter and Mazé, 2010). The 3Ecologies model is developed into a digital visualisation tool that does not only analyse current design but also explores future design potentials. This model uses diagrams to visualise product lifecycle(s) to analyse and speculative lifecycle(s) influenced by sociological, psychological and environmental factors to explore multiple possible product futures beyond the mainstream product lifecycle.

In Ávila's later work (2019), he brings in posthumanist discourse to address the nonhuman in his model. Ávila draws on the concepts of intersectionality and diffraction from Guattari's three ecologies to create an ecological design with relational thinking concerning various kinds of being beyond the human and the intersections between social, psychological and environmental dimensions. His practice of designing different devices to connect different species suggests ways that we may cohabitate with nonhumans and care more about ecology by decentring the human and admitting other beings' different existences and relationships with us. Ávila argues that designers should ecologise design to 'provoke a shift in our practices in an attempt to move from a (Eurocentric) anthropocentrism to a pluriversal biocentrism and to develop devices that perform human responses co-inspired by and for multispecies cohabitation' (2021, p. 240).

The three ecologies inspire Ávila's design research and offer a perspective from which to understand design. At the same time, the processes of design and the lives of design artefacts contribute new knowledge to design and add perspectives to the theory. Ávila's relational approach may be framed less as a direct effort at problem-solving and more of a poetic design inspiration. He works to understand design through the three ecologies and to expand the boundaries of design by putting that theory into practice.

2.3.4.2 On a Multi-Technologies Perspective

Like the three ecologies in Guattari's and Ávila's work, technology can also be viewed as having different layers and spaces for individual, societal and ecological systems. In many situations, technology, which provides instruments independent of local value systems and may be employed unbiasedly in support of highly varied Life Styles, is neutral on the cultural, moral and political levels. While technology is not neutral if we see it as part of life, technological objects must fit into a Life Style pattern of one kind or another. Arnold Pacey (1983) uses the notion of 'technology-practice' instead of technology to show that technology is not value-free or politically neutral. Technology-practice can be described as applying different knowledge to practical tasks through systems of organisations, living things and machines. Under this definition, Pacey argues that the general meaning of technology includes cultural aspects.

Further, Pacey (2001) argues that technology needs to consider the personal experience and imaginative or affective responses to technology at the individual level and is primarily an 'expression of varied technology'. 'Tacit knowledge' and human-centred design can show the importance of experience in technology development. Individual experience of technology can facilitate a 'deep ecology' transition from human-centred technology that values humans too highly and nature not enough to a 'plutocentric' technology that values human and nature jointly and accepts that some human-centred values will be changed by ecological consciousness (Devall and Sessions, 2007; Pacey, 2001). Pacey (2001) also provides three ways to support this transition through individual experience and ethical responsibility in technology.

In addition to the cultural perspective counter to a determinist and neutral view of technology, Andrew Feenberg (1992) adopts a 'critical theory of technology' perspective to view technology as more than 'rational control of nature', acknowledging that its evolution and influence are strongly affected by and intertwined with societal dynamics. From a determinist view, technologies like science and math have an autonomous functional logic; they are social only because they serve a subjective human goal. In contrast to determinism, Feenberg (1992) argues that technical objects have two hermeneutic aspects: 'social meaning' and 'cultural horizon.' The social role of technical objects and the Life Styles they enable can be expressed as social meaning, which is always accompanied by a functional rationality that removes objects from their social contexts to analyse them in functional systems. The cultural horizon is formed by social codes established by the 'cultural and political struggles' to define a niche to a wide range of possible technologies for selections, social environment and Life Styles (Feenberg, 1992, 2011). Technology can be seen as subversive rationalization, not an angel and not a monster, concerning humans and nature with technological activities and responsibilities.

In his recent work, Feenberg (2017) points out that the technology-experience dualism is an obstacle to technological development because technical knowledge is incomplete without input from experience. Technical relationality is consistent with 'informal common-sense rationality' arising from everyday experience influenced by identity and values (i.e., everyday relationality) (Feenberg, 2011, p. 872). Feenberg (2017) writes that when using traditional wood crafting techniques, it is easy to experience the actions of those and their causal feedback and effects of meaning. One consequence of technical change is typically the assumption of a new identity, which is frequently more a requirement than a practical aim. This is obvious in a consumer society, where products are created more for identity than for pure function.

Further, some new critiques of technology from an ethical and posthumanist view are about how human identity which can be dramatically changed by technology. Hayles and Haraway, who focus on human enhancement and posthumanism in technology, argue that this shift in subjectivity has brought humanity to a point where it takes seriously arguments concerning the moral position of artificial instead of human life[25]. The cyborg concept is not just a matter of adding technology to an existing human subject, nor is it a matter of transferring a human mind or self to a computer or robot, as Hayles has argued. This questions the fundamental notion of humanity, for which technology is only a prosthesis or complement.

25 In *How We Became Posthuman*, Hayles (1999) explores the consequences of converting bodies into information via digital technologies, such as downloading the brain into a computer. This reflects the digitalisation technology on pure digital social interactions online or pure digital final system through Hayles's assumption. Haraway's (1991) notion of the hybrid, partial or non-unitary cyborg identity challenges dualisms. It suggests a nonhumanist posthuman identity, including organic and technological beings, human and animal, self and other, male and female.

2.3.4.3 On Cosmotechnics

Unlike the posthumanist attitude towards technology, Yuk Hui argues for positive roles of technology in ecology. Hui (2017) introduces the concept of 'cosmotechnics' to critique the nature-culture dualism from a non-Western perspective and to rebuild relationships between cosmology, morality and technology that have disappeared in the Anthropocene. First, cosmotechnics is 'the unification of the cosmic order and moral order through technical activities' (p. 4) and addresses modern technology-related issues like determinism, which separates the cosmic from the moral order. Nonhuman and human involvement in cosmotechnics differ from one culture to another, depending on diverse cosmologies, which are paradigms that define forms of involvement and the moral foundations for such involvement.

Morality is derived from cosmology or revealed through a specific interpretation of nature, as evinced by the ethnography of gift economies (Mauss, 2013) and harvest ceremonies (Abram, 1997). Humans organise their experiences through technical practices that define habits, rituals and value systems and concretely embed them in the environment around them. In other words, cosmotechnics argues that humans constitute the technical in that every culture uses technical practices and is shaped by them in its psychophysical and eco-symbolic organisation (Pavanini, 2020).

Second, cosmotechnics may provide new insights to reconcile the conflict between the local and the global. The globalisation of technology driven by Western epistemology and economic and military competition has forced non-Western cultures to copy or adapt to the global standard of technology (Hui, 2020) and has rendered us oblivious to the diversity of cosmotechnics. Based on European humanism, technology builds up a dualism between tradition and modernity that focuses only on advanced technology, which means modernity exacerbates determinism and accelerationism (Hui, 2017, 2020). This dualism requires us to reconsider processes of modernisation and globalisation and the possibilities of repositioning new technology. Locality could create a multiplicity of cosmotechnics or a kind of techno-diversity. Here, locality means the ability to reflect on the technological transformation of the local and construct their technological thinking and future, not to return to some traditionalism. Locality also defines a new relationship between machine and ecology by relocating the technical into its geographical milieu (the cosmic order), culture (the moral order) and thought (Hui, 2020, p. 64). This means that design needs to explore cosmotechnical diversity instead of linear advancement. In this way, local environments are not only those that are modified by local technologies but are also more and more constituted by those local technologies, and technodiversity can be seen as another form of biodiversity.

2.3.4.4 On the Connections Between Ecology, Culture and Technology

Guattari's views on ecology and Pacey's understanding of technology are posed at different levels from society to the individual and from different perspectives of ecology and culture.

Feenberg critiques the technology-culture dualism, which leads to determinism. Hui connects technology with nature and culture to respond to the Anthropocene as a problem of the human technical system. The relationships of elements in the theories of Guattari, Pacey, Feenberg, Hui and posthumanists intersect with one another in an Eco-Cultural-Techno system.

If an Eco-Cultural-Techno system is so complex, a key question emerges: how can we analyse design in such a system? Life Style and Life Form may be the answers because they also exist within an Eco-Cultural-Techno system or relational rather than rational thinking. In Chapter 5, I introduce how design can connect the three areas through a speculative design conceptualisation called the Speculative Life-Style-Form Design Perspective. This Perspective is explored by being applied to my two speculative design works related to cultural everyday human life and my discussion of the potential for new relationships that are prompted and perhaps realised between ecology, culture and technology beyond the human world. I also introduce nondualist posthumanist relational thinking in the next section.

2.3.4.5 On Plural Perspectives

Matters of diversity and perhaps intersecting world views are also important in relational perspectives between ecology, culture and technology. As a Chinese designer-researcher, I am influenced philosophically and culturally by Confucianism. Many Chinese designers have tried to use Daoism to reshape design practice and remain close to nature for the purposes of sustainability and harmony. For Daoists, *Taiji* is a Chinese term to describe the 'Supreme Ultimate' state of the unlimited potential and undifferentiated absolute and infinite potential before the duality between yin and yang emerged. The symbol of *Taiji* is made of one white part (yang) and one black part (yin). The dualist symbol reveals the dynamic world and how it operates. Yin and yang interact and integrate with each other to produce everything in the world. This dualist visualisation symbolises the dynamics and potential of becoming rather than a set of opposites.

Chinese Confucianism further explains the mutual forces of *Taiji* through the concept of the 'unity of heaven and humanity' by which humans are part of cosmology and participate in the cosmic process through forces that involve both humans and nonhumans (Tu, 2001). In my view, Chinese Confucianism and *Taiji* can inform an ecologically relational ontology that includes such thinking, where relations are placed in different or opposing groups and help us understand elements and their larger links in new holistic entities. The focus may be less on a universal totality and more on the dynamics of building relations synergistically and in mutual dialogue.

The way to participate in cosmology from *Taiji* can also be referred as a posthumanist Chinese concept and adopts a worldview similar to Guattari's machine heterogenesis, which is 'founded

at the crossroads of the most complex and the most heterogeneous enunciative components' (1993, p. 22). Wong Kin Yuen (2021) used Chinese kung fu films to argue for posthuman Daoism, where the wisdom of kung fu is that weapons like swords and humans can become one when performing together. This is similar to Deleuze's cosmic artisan. An artist's tool might become a reciprocating agency in a feedback loop that begins with the artist's projection of the tool's potential force (Deleuze and Guattari, 1987, p. 345). This feedback loop can be further explained by the concept of assemblage introduced by Deleuze and Guattari (1987), which describes the spatiotemporal composition of humans and/or nonhumans as unpredictable creatures. Nonhumans, like material things, can be understood as part of a continuous endeavour to construct order and meaning from a never-ending stream of experiences. Posthuman Daoism suggests that we are natural cyborgs or assemblages of the human, technical objects and environments, while *Taiji* holds that humans and nonhumans can exist together to generate actions and nonactions in chaos, the cosmos and environments embodied in time. These interactions between humans and nonhumans can be viewed as synergistic relations rather than isolated actions.

Francois Jullien (2004) also discusses the focus of synergistic relations through warfare to discuss the difference between Chinese and Western cultures and to compare key word pairs: goal versus consequence, action versus transformation and persuasion versus manipulation. Generally, the difference between Western and Chinese thought is that 'one constructs a model that is then projected onto the situation, which implies that the situation is momentarily "frozen." The other relies on the situation as on a disposition that is known to be constantly evolving' (p. 189).

The West regards actions as a way to change the world to achieve a predetermined goal. This perspective has produced substantial success in the sciences, but it frequently frustrates interactions between humans and their environments. Compared with the Western perspective, the Chinese aim is transformation rather than action. Successful transformation needs to examine a situation as part of an ongoing present, interpret the tendencies offered and alter circumstances in subtle ways to enable the emergence of a framework in which the desired goal will come about of its own accord[26].

The theme of transformation runs through modern Chinese history, which addresses technological development to challenge the dominant West, and postcolonialism, Third World modernism and Marxist humanism challenge Eurocentrism by exploring the alternative path of

26 The notion of transformation in Chinese culture reveals the sensibility of causality that all elements of a situation contribute to the formation of consequences and causes. Causes and effects are not isolated entities, and action is not targeted to change our world and is an integral part of world becoming. This Chinese view on transformation may provide alternative relational thinking for the west posthumanism.

development from multiple 'post' perspectives to respect multiple humans (Shih, 2012). This is rarely discussed in posthumanism but has many similarities with posthumanist views. The history of science fiction in China also reveals that Chinese posthumanism can provide insights into the country's transformations to consolidate and reinvent a multitude of general norms, cultural aspects and political visions by imagining technological developments and a non-anthropocentric world (Song, 2017). The work of Chinese writer Cixin Liu is a good example. In *The Three-Body Trilogy*, Liu constructs a fictional world where the extinction of humans has no impact on the universal and existence depends on the kindness of a superior alien species.

In my work, I seek to connect the three aspects of ecology, culture and technology by creating a mixed space of East and West for my design experiments on global issue climate change. As a potential common space in my research, posthumanism includes multiple views from feminism, postcolonialism, Chinese philosophy and other strains of thought, which move beyond unequal relationships and dualism. As a Chinese person, I have reviewed some unfamiliar literature from the West on posthumanism to find inspiration and raise questions for my practice-based research in the next section, still keeping my sensitivity to Chinese culture. Finally, I use speculative design as a method to propose a theory that transcends East and West and build a relational and posthumanist ecological design perspective on sustainability, which I explain in Chapters 3, 4 and 5.

2.4 Posthumanism

In the previous section, I noted that Hui and other scholars have proposed a world that opposes separations between technology and nature and focuses on Life Form as part of a cultural take on design suggesting that humans think and act and exist as non-dualistic biocultural creatures. Nondualism, as a broad worldview, is the key feature of posthumanism. In brief, posthumanism hopes to pull us out of humanism and has been adopted as a means to address the various challenges of the Anthropocene. Next, I provide a brief introduction to posthumanism and focus on key concepts connected to the main motivations for my research. In the following citations, posthumanist thoughts are dynamically displayed through practices in which 'practice as theory' is advocated (Bogost, 2012).

2.4.1 Key Considerations in Posthumanism

2.4.1.1 Broad Framings

For Ferrando (2013), the term

> 'posthuman' has become an umbrella term to include (philosophical, cultural and critical) posthumanism, transhumanism (in its variants as extropianism, liberal and democratic transhumanism, among other currents), new materialisms (a specific feminist development within the posthumanist frame), and the heterogeneous landscapes of antihumanism, posthumanities, and metahumanities. (p. 26)

Posthumanism may be understood as a space in which those how have moved beyond humanism live and describes a world without boundaries between the human and the nonhuman, between culture and nature, between science and humanity, and so on. This offers a hybrid and relational tool to critique the contemporary human condition of species supremacy and to explore what we are becoming (Braidotti, 2019). Posthumanism can be understood through the paradigms of non-anthropocentrism and nondualism.

Non-anthropocentrism requires humans to give up their hegemonic role on the planet and their liberal individualism, realise the value of other earthlings and cohabit with them in the face of the Anthropocene's ecological devastation and social precariousness. Non-anthropocentrism can be found in the definition of the posthuman subject and cultural anthropology.

2.4.1.2 Posthuman Subjectivity and Environments

Braidotti (2013) defines the posthuman subject 'within an eco-philosophy of multiple belongings, as a relational subject constituted in and by multiplicity, that is to say, a subject that works across differences and is also internally differentiated, but still grounded and accountable. Posthuman subjectivity expresses an embodied and embedded and hence 'partial form of accountability, based on a strong sense of collectivity, relationality and hence community building' (p. 49). Similarly, Margulis and Sagan (1995) argue that subjectivity does not only mean human but is a cooperative transspecies effort that is not limited to bound individuals.

Anna Tsing (2015) uses the matsutake mushroom's resilience to show that humans are only cohabiting on the planet rather than the centre of the world. Matsutake can symbiotically coexist with other species as multispecies 'assemblages' to survive destroyed environments and form new environments. The environments form unintentionally by interactions between human and nonhuman in a process that sees 'humans joining other living beings in shaping worlds' (p. 152). Tsing also works with other cultural anthropologists' studies of the smell of matsutake to explore human and nonhuman relations (Choy et al., 2009). Humans and mushrooms share sensitivity to chemicals related to 'scent', which bridges the gap between humans and non-humans. From both the mushroom and human perspectives, smell indicates a 'multispecies connection' and creates a 'new form of collaboration' (p. 382).

2.4.1.3 Nondualism and Metamorphosis

Nondualism breaks the binaries of the posthuman world from different perspectives and at different layers. Non-anthropocentrism can also be understood as a way to view human and nonhuman in a nondualistic fashion. One of the most renowned nondualist scholars is Donna Haraway, who argues that scientific and technological development will break the boundaries of human-animal, human/animal-machine and physical-non-physical (1991). She suggests giving up the dualism between nature and culture and human and environment, since humans

lived and have lived in many complex systems that are or were inextricably entangled with other species, environment and technology (Haraway, 2007). Jussi Parikka (2010) has also argued for nondualism between animal bodies and diagrammatic control: studying the perceptual system of animals is similar in logic to studying what kinds of local information is to be set up to create knowledge for an intelligent robot to understand its surroundings.

A non-anthropocentric view could be placed on a cosmic level to discuss our survival, sustainability and ecology from a posthumanist perspective. Like Hui's 'cosmotechnical', Clarke (2008) argues that we need to have the capacity to continue to survive or sustain ourselves by coordinating our systems with instruments of the geobiological environment '(meta)symbiotically' and then to become posthuman:

> The organic bodies and ecosystems we impose our technologies on are not beneath us but beyond us, even while all around us, even while sharing us with an environment as yet fit for life. Whether it wants to or not, humanity will have to post itself to the Gaian conception of its embeddedness within geobiological phenomena that are planetary and cosmic in scope. It will earn its continuation only by metamorphic integration into new evolutionary syntheses. (pp. 195-196)

We need to give up the dualism between mind and body and embedded and embodied; they cannot be divided, as is clear from the discussion of the concept of 'biocultural creatures' above. Braidotti (2011) illustrates the nomadic version of body: 'The body or the embodiment of the subject is to be understood as neither a biological nor a sociological category, but rather as a point of overlapping between the physical, the symbolic, and the sociological' (p. 25).

Through technological modifications, the body as subjectivity becomes a new materialisation influenced by interactions and new relationships between body and mind. In both reality and imagination, bodies become 'infinitely malleable, plastic and liquid, to be performed and invented anew' (Rossini, 2017, p. 153): all bodies, including nonhumans, co-exist and coevolve within a cultural-technoscientific system.

Posthumanism itself may can be viewed as a dualism between the Anthropocene and modernity. In Down to Earth, Bruno Latour (2018) describes the denial of climate change as a kind of tool of the 'super-rich' and 'elites' to disinform people of the facts of climate change. The form of denial is plural, but the goal is to turn the plurality of our world into a standard vision constructed by a small elite with limited interest and knowledge – the concepts of denial separate humans' experience of our earth and the way of global living. Latour calls for a new language which can depict our heterogeneous, plural, complex and interconnected earth rather than creating a dualism between humans and our environment or the earth. This new language may be referred to as posthumanism, which can help us correctly understand the irreplaceability of our planet and imagine a world beyond anthropocentrism (Burke et al., 2016). Posthumanism can be deployed as a language to help us escape from the dangerous world to experience a new

future and live new everyday lives. But we may misunderstand this hope of out of the damaged world. Hope is predicated on ontological uncertainty, with the potential to break out from a linear and dependent path, compared with optimism, which is based on the certainty of following a planned path (Eagleton, 2015). When faced with the Anthropocene and urgent climate crisis, posthumanism seeks to escape from the capitalist and anthropocentric world decisively and to opposed the past. This may be viewed as another dualism between the certain and uncertain.

Wrangel and Causevic (2021) critique Latour's view on climate change denial from a non-dualist perspective between the Anthropocene and modernity. They argue that denial does not arise from ignorance about climate change but from socially organised and mediated knowledge that seeks to maintain a consumerist and capitalist everyday life. They call for a theoretical and open approach to study how modernity and the Anthropocene interact through their performance, their experience and their current actions upon on us. The possibilities of the posthuman world are about not only variation but also realistic change beyond a new language. This is why I use the posthumanist view to explore and discuss current consumerism issues like cosmetics.

2.4.1.4 Feminist Perspectives

Other posthumanist researchers also have similar concepts regarding Gaia, such as the feminist Braidotti's (2013, p. 88) notion of the posthuman as becoming-earth. Braidotti adds a post-anthropocentric layer that concerns a planetary, geo-centred perspective to deal with ecological sustainability in the context of climate change and the Anthropocene. More and more feminists have approached ecological issues with a posthumanist perspective. International Perspectives in Feminist Ecocriticism (Gaard, Estok and Oppermann, 2015) recommends shifting a focus from gender to a more generally ecological view of human and nonhuman relations, including biological beings and cyborgs within sociotechnical systems.

Feminists with a posthumanist view also argue for a post-disciplinary approach (Lykke, 2010) based on feminist studies and cultural studies, which can be viewed as nondualist, posthuman fields and are often deployed in the environmental humanities. This transdisciplinary approach addresses both ecological and cultural issues and is intended to provoke profound analysis and innovative methodology through participatory workshops and processes of elaborative collaborative making such as co-writing and designing to challenge the dualisms found in different disciplines, research and practices. My research respects these feminist ontologies from the environmental humanities; they inspire me to adopt a nondualist research view embracing speculative making as a research method on which I elaborate in the next chapter.

Feminists also have conducted transdisciplinary transcultural studies to combine Western-centred and Indigenous knowledge to address ecological issues from a nondualist,

posthumanist approach (TallBear, 2015). Researchers have found that Indigenous knowledge has some similarities with posthumanism in that Indigenous cosmologies do not feature a dualism between humans and nonhumans, including stones, thunder and stars. This is not common in Western philosophical ontology.

2.4.1.5 Design Perspectives on Posthumanism

Laura Forlano (2017) presents more examples of design practices related to posthumanism and relational thinking concerning the relations between human and nonhuman. Forlano addresses the importance of giving up a human- and user-centred paradigm in design when we face the need for sustainable transformations within complex sociotechnical systems. Then, she reviews different theories from posthumanism, actor-network theory, feminist new materialism, object-oriented ontology (OOO), non-representational theory and transhumanism. She further discusses the relationships between these theories and design by reviewing existing design practices to elaborate on the potential of posthumanism in the design field. She finally argues that hybrid, nonbinary, and relational thinking and concepts from posthumanism will transform the research and practice focus of design from rationality, management and the binary to relationality, uncertainty and the plural when it comes to climate change issues and the Anthropocene.

Forlano (2017) also discusses the critiques of posthumanism in terms of critical race theory and decolonial theory and their influence on future design research and practices that address the equality of humans and nonhumans, which has typically not been a factor in design processes. The human notion in OOO does not adequately include non-white people, Indigenous people, people with disabilities, and others from a critical race study perspective.

These critiques are in some way similar to the critiques of speculative design discussed above. In this thesis, my strategy is to address nondualism from many perspectives: East and West, human and nonhuman, Indigenous and modern, and so on. None of these actually has a clear boundary, and I deliberately mix them to broaden the space of design research and practice.

2.4.2 Relational Thinking

2.4.2.1 Relational Thinking and Sustainability

The past two decades have witnessed the emergence of theories concerned with framing and positioning relational thinking and ontologies connected to object-oriented analyses. In the broadest terms, relational ontologies strive to transcend the dualisms of modernity (Bryant, 2011; Hui, 2017; Parikka, 2010; Wolfe, 2009). Through differentiated relational ontologies, individual integrity can help recognise how all kinds of interactions essentially influence their being. Speculative realism, process philosophy and new materialism have established rich knowledge to understand relational ontology relevant to ecology and sustainability.

2.4.2.2 Things at the Centre

First, I use OOO, one variation of speculative realism, as an example to explain relational thinking since OOO has already been applied in some design and architecture schools. OOO uses flat ontologies in which everything can be divided into two kinds of objects: 'real' and 'sensual' objects (Harman, 2017). Every object is equal, which can challenge dualism and anthropocentrism (Bogost, 2012; Bryant, 2011; Harman, 2017). Bogost's (2012) explanation[27] of OOO shows the false assumption common in our world that everything exists must be 'physical', 'basic', 'simple', 'real', and 'able to be stated accurately in literal propositional language'(Harman, 2017). These assumptions are caused by Enlightenment humanism, dualism, reductionism and determinism. In contrast to these false assumptions, there are two key phenomena in OOO. First, every object has a 'surplus' beyond its basic elements and underneath its full amount of impact (Harman, 2013, 2017). Second, two real objects come into contact only through the sensual qualities they offer each other rather than through direct contact (Harman, 2017).

Even though OOO and other relational approaches like actor-network theory focus on dynamic and changing relationships between human and nonhuman at different scales, OOO not only focuses on these relationship processes but also on the real qualities of other beings in those relationships, which can make human and nonhuman more equal and thus facilitate a deep discussion of ecological problems (Bogost, 2012).

2.4.2.3 On Diffractive Approaches

Feminist researchers in science and technology studies have developed a diffractive approach (Haraway, 1997) to address nondualism and transdisciplinary and relational thinking in qualitative inquiry towards ecological complexity (Barad, 2007; Hill, 2017). Diffraction is a physical phenomenon that occurs when different waves collide with one another or with an object on their route. Diffraction challenges the 'wave-particle duality paradox' from quantum physics. In different situations, light can be like particles or waves. Feminists use diffraction as a metaphor to reveal that we live in a relational and nondualist world composed of encountered differences.

Barad (2007) considers diffractive methods as 'reading insights through one another in ways that help illuminate differences as they emerge: how different differences get made, what gets excluded, and how those exclusions matter' (p. 25). This means that diffractive methodology is

27 His explanation in detail: 'OOO puts things at the centre of being. We humans are elements, but not the sole elements, of philosophical interest. OOO contends that nothing has special status, but that everything exists equally—plumbers, cotton, bonobos, DVD players, and sandstone, for example. In contemporary thought, things are usually taken either as the aggregation of ever smaller bits (scientific naturalism) or as constructions of human behaviour and society (social relativism). OOO steers a path between the two, drawing attention to things at all scales (from atoms to alpacas, bits to blinis) and pondering their nature and relations with one another as much with ourselves' (p. 6).

a critical engagement practice that can create differences in the world and figure out what differences matter, how they matter, and to whom they matter (Barad, 2007; Haraway, 1997). The diffractive approach thus becomes 'a material practice of making a difference, for topologically reconfiguring connections' (Barad, 2007, p. 381). The approach addresses respect and dialogues of differences between concepts and theories, which can make connections between them 'creative and unexpected outcomes' (Barad, 2007, p. 30). This also means that the diffractive approach is a transdisciplinary methodology to blur the boundaries between different concepts and theories to provoke new thoughts.

In a diffractive view, knowing is constantly influenced by a combination of different connections, not an isolated process (Barad, 2007; Mazzei, 2014). Using the diffractive method, researchers can understand one discipline through the lens of another to interpret and analyse differences to gain new insights into material entanglement and new relationships (Doucet, 2018; Mazzei, 2014). In this way, diffraction becomes a material-discursive and critical practice to respond to the material entanglements in agential becoming and a tool of analysis for responding to the impacts of differences in those entanglements.

2.4.2.4 On A Relational View for Design towards Sustainable Futures

OOO and diffractive approach reveal that posthumanist relational thinking can challenge multiple dualism and anthropocentrism, which causes contemporary challenges. With relational thinking, there is a need to build a relational view for design towards sustainable futures. Similar to Forlano's views on relational thinking of posthumanism and design, Zack Walsh, Jessica Böhme and Christine Wamsler (2021) map out three different relational approaches – ontology, epistemology and ethics – to position relational thinking in sustainability by analysing a hundred relevant publications. They identify a relational paradigm of sustainability that has three characteristics: '(i) it is grounded in a relational ontology; (ii) it emphasises the need for understanding human and nonhuman nature as mutually constitutive; and (iii) it values more-than-human relations' (p. 80).

Unsustainable societies are rooted in the dualism caused by modern solutionism, anthropocentrism and a Western-centric worldview. The ontology of relational thinking about sustainability, according to these authors, aims to transcend the various dualisms that shape modern worldviews and raise awareness that all sorts of connections create a given individual's wholeness. The epistemology of relational thinking on sustainability provides a transdisciplinary means to analysing objects, which are assemblages of humans and nonhumans, as multiple ways of knowing.

For Walsh et al. (2021), the ethics of relational thinking on sustainability suggests that we need to adopt non-anthropocentric and nondualist perspectives as cultural values of our societies. In my research, the ethical part has already been integrated into the ontological and

epistemological parts. Based on Walsh et al., I have drawn a diagram (Figure 2.5) that maps out the relationships between the different theories I studied and relational thinking. The diagram shows that posthumanism is closely connected to ethics, which is embedded in posthumanist thoughts through its nondualist and non-anthropocentric perspective. My work is based on the notion of nondualism and non-anthropocentrism and always involves ethical judgement.

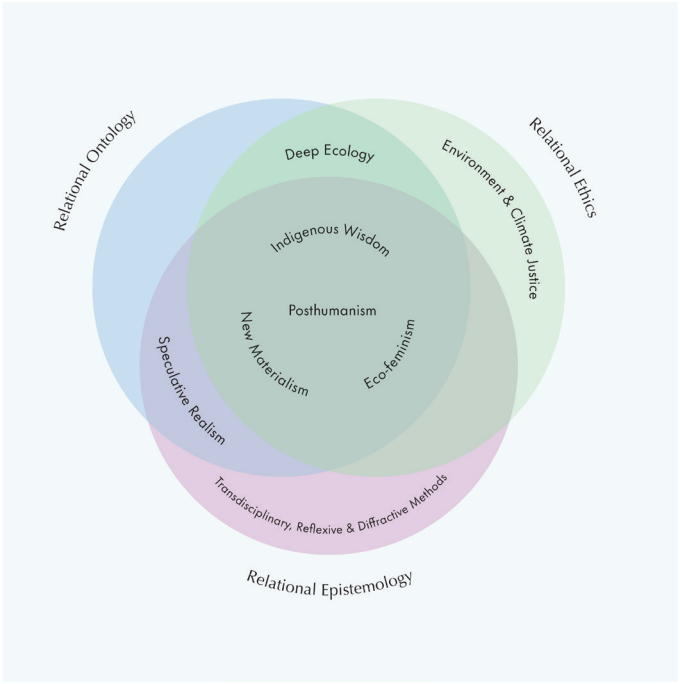


Figure 2.5 Relationship between the different theories studied and relational thinking (Zou, 2021).

Challenging the dualism between ontology and epistemology through relational thinking of ecology, Witzgall (2021b) uses Barad's (2007, 2012) methodology to argue that ecological thinking is a kind of relational onto-epistemology:

> Ecological thinking as relational onto-epistemology conceives the various material-semantic actors in the world's assemblages and networks as variously individuated actualizations that are subject to further individuation or differentiation and differentiation in relation to other human and non-human elements of this web.
>
> Ecological thinking as relational onto-epistemology understands the generation of knowledge as a relational intra-active practice in which representations and epistemic tools do not mirror the world from a distance in a representationalist manner, but rather contribute as directly involved actors to its reconfiguration. (p. 87)

A relational approach is taken to explore presumptive relationships of being and becoming and how to bring different things together to form these relationships. The non-representational and intra-active knowledge in this approach are responses to the status quo, which is difficult to change. Further, in a diffractive process, linking and delinking relationships involve

thinking through and with the knowledge of a variety of disciplines through an alternative practice or particular view. The knowledge produced with the diffractive process may be said to be polycultural instead of reflecting a monoculture.

Given these varied perspectives on posthumanism, relational thinking and changing knowledge-making, questions arise for design about how they may be connected and linked with processes, products, interactions, services and systems. I argue here that adopting an ecological and relational view offers one means for design to help allow us to rethink relationships between human and nonhuman and human and nature and our human positions in producing polycultural knowledge towards sustainable futures. I suggest that this may be enhanced through relational and diffractive inquiry and multiple ways of knowing. I elaborate on diffractive inquiry through speculative making in Chapter 3.

2.5 Clarification of Complex Concepts

Many complex or very broad terms have emerged in this transdisciplinary literature review, such as ecology, culture and technology. Each touches on several academic fields, which is why only a few studies have connected all three in their analysis. However, my research emphasises reaching beyond modernist dualism and binaries, so connecting the three through design in this study is nothing less than essential. From a Chinese cultural view, all things are connected in the cosmic system; even opposing words are mutually encompassing, with a background to the other rather than its diametrical opposite (Hui, 2019). This also refers to Redström's design idea (2017, p. 2) on dualism that design practices use dichotomies to open perspectives. Below, I clarify some of the difficult words to define from a design perspective. I introduce them in groups rather than individually, as they serve as backgrounds to one another as their definitions are revealed.

Climate Change, Anthropocene and Wicked Problem

Climate change, the Anthropocene and wicked problems all have connotations of dilemma, uncertainty, intractability and negativity. In my research, these three terms together reveal a crisis in which humanity is already embedded and an awareness that new approaches are needed to address that crisis. Both climate change and the Anthropocene indicate a context in which current human activities impact our environment and affect our survival; they are also symptoms of long-running human systems (Folke et al., 2021), and their definitions are plural in that they can involve different human activities (Haraway, 2015). They are similar to the wicked problem notion posed by Rittel (1972), which describes vaguely defined problems in which the choice of solution is accompanied by conflicting values and any proposed outcome is ambiguous.

Many design researchers elaborate on the relationship between design and wicked problems (e.g., Buchanan, 1992; Burge and McCall, 2015; Coyne, 2005; Suoheimo, Vasques and Rytilahti, 2021). As a discipline, design has the ability to deal with wicked problems by working towards complex human-artefact systems (Buchanan, 1992). At the same time, wicked problems for design need to be defined and carefully managed since any wicked problem is inherently complex and has different causes (Burge and McCall, 2015) and typologies (Suoheimo, Vasques and Rytilahti, 2021). For me, the most impressive characteristic of a wicked problem 'is thus the same thing as finding the solution; the problem can't be defined until the solution has been found' (Rittel and Webber, 1973). This is a response to the shift in design approaches from problem-solving to scenario-building (Fry, 2009; Margolin, 2007; Wood, 2016). In this study, climate change, the Anthropocene and wicked problems serve as both conditions and issues that allow me to use making futures as an approach to stay with the trouble (Haraway, 2016) instead of simply seeking to solve problems.

Sustainability, Flourishing and Wellbeing

Wellbeing and flourishing are two focuses of sustainability. Initially, sustainability had an anthropocentric view in which people were viewed as able to sustain current and future generations of the species (WCED, 1987). From a non-anthropocentric view, we cannot sustain ourselves by focusing on ourselves and surviving on our own. Sustainability thus became a process to shape the relationship between humans and nonhumans so that they can grow, adapt and maintain wellbeing together and achieve a flourishing relationship (Bagheri and Hjorth, 2007; Ehrenfeld and Hoffman, 2013; Holling, 2001). In this research, sustainability describes a healing process for the earth to achieve a flourishing relationship among all species by caring for the wellbeing of the nonhuman.

Futures, Speculation and Refuturing

Futures in this research refers to both making processes and design outcomes. Speculation is key to making futures. In design, speculation addresses the importance of the imaginary or imagination in this research and is a non-dualist process in which design can reflect its process and process can influence design (Redström, 2017). This relational perspective between process and result is one way to produce knowledge using plural futures. We have many ways to describe making futures, such as refuturing, which has been central to the wider designBRICS project. Refuturing, as outlined by designBRICS researcher Jomy Joseph (2021, p. 110), intends 'to break the constantly narrowing frames of "Business as Usual" (BAU)' and to offer instead 'a designerly reimagining, rethinking, and "re-humanizing" of futures', following the work of Freire. Futures through speculation and discussing refuturing can offer plural possibilities through which hopeful, imaginary and radical alternatives may offer options, possibilities and motivators as a design environment for change.

Posthumanism, Consumerism and Cosmetics

In this research, posthumanism involves multiple perspectives that could connect to design research, challenge consumerism and reframe cosmetics. In posthumanism, three key topics have come to my attention. First, humans must eliminate anthropocentrism. We cannot believe that we only live in a human-made world and consume resources through recycling without harming other species, and we must accept that humans are only part of our ecology (Morton, 2018). Second, humans must eliminate dualism, which can cause reductionism (Ito, 2017) and determinism (Feenberg, 1992) that threaten sustainable development. To combat reductionism and determinism, cosmetics in this research moves beyond a consumerist symbol and has rich meanings in the context of high-tech devices, beauty, health, wellbeing and further flourishing relationships. Third, relational thinking opposes anthropocentrism and dualism and offers ways for design to contribute to sustainability (Walsh et al., 2021); ideas from posthumanism are all paradigm transitions for our society. Design itself also needs transitions towards sustainability. In this research, I use these concepts and knowledge from posthumanism to construct design knowledge and understand posthumanism to construct design that aligns with posthumanist worldviews (Brassett, 2015).

2.6 Chapter Conclusion

Having considered these domain areas and transdisciplinary perspectives and the relations between the human and nonhuman, environment and ecology and culture and technology, I have positioned the perspectives in relation to my core concern to understand relations that may help better understand sustainability and design from a wider posthumanist view. This view is seldom discussed in the existing literature. The present study tries to find a relational approach to address climate change both culturally and technologically. This is a perspective in which speculative design provides a means to imaginatively and generatively develop possible, potential, prospective and even anticipatory views for exploring and positioning relational thinking and design futures. It attempts to connect sustainable design with posthumanism to form a new understanding of how to undertake design actions around related topics change and futures based on the urgent and complex issue of climate change.

Before moving on to the next chapter, the reader is encouraged to read the three publications. The first chapter offered an initial look at the XIANGVEI and LO projects. In the second and third publications, these projects are discussed in much greater detail. In the next chapter of the thesis, Sections 3.4.2 and 3.4.3 present how the prototypes of the two projects were made. Section 5.4 shows how the Perspective schematic I developed was put to work in these two projects. Finally, in Chapter 6, I discuss these two projects further in a larger context through the Approach schematic. This structure helps understand how the two projects work throughout the thesis as a whole and to see the role and significance of the different layers of designing.

3. Research Methodology and Methods, Design Tools and Techniques

3.1 Introduction

3.1.1 Context

When researching design perspectives on matters of climate change, we are confronted with several key challenges, the first of which is whether design can and will be able to engage sufficiently in the critical, difficult and demanding matters and issues and changes that must be acknowledged in order to meet these challenges. There is an urgent need to address the role of design in the context of rising temperatures, global negotiations about strategies and policies and actually effective actions to reduce the underlying causes of global warming and the related climate emergency.

In this thesis, I suggest that there is indeed room for critical and imaginary projects, such as the works I have developed in the realm of speculative design. Such works may play an important role thinking with and through speculative methods and means in the context of complex systems, relations and design-centred communication. For example, speculative design objects are constructed by narratives outside and scenarios of use through contextualising technology and technocratic visualisation (Malpass, 2017). It is typical in everyday life contexts to discuss technology within a socio-cultural system and encourage reflections on the work.

My research is a part of AHO's ReFuturing Studio and the related designBRICS network type research project. The studio and project investigate diverse but shared futures as forms and modes of new dialogues between the Global North and Global South centred on quality of life and alternative design futures. Importantly, this contrasts with the dominant, inherited consumption-based approaches. We have argued that design should investigate futures and go into their making beyond a business-as-usual model. My fellow doctoral student in the project, Jomy Joseph, has framed this as follows:

> The notion of 'ReFuturing' enables long-term sustainable futures by means of rethinking and reimagining futures as material and ecological consequences of climate breakdown that our designed culture in the coming

century will face and even beyond the ones we are experiencing today[28].

Despite arguments about the naming and substance of what has now been widely called the Anthropocene (Folke et al., 2021), our global climate emergency challenges design to address many of its modernist assumptions, economic models of raw material extraction and a consumerist logic of apparently endless growth (Klein, 2015). What methodological stances might we take and explore, and how may our research and design methods be chosen and used to address these problems and provide alternatives to their dystopian, destructive characterisation and related practices?

In this chapter, I ask several connected questions. How might we go about selecting and positioning design methodologies and speculative inquiry in a mode of research through speculative design? What research methods might we choose, and how could they be applied in the context of a broader engagement with shaping and communicating potential, imaginaries and criticality through such works? How might my identification and use of design techniques and tools impact my design work and the kinds of knowing it might facilitate? In answering these questions, I position the methodology, the various methods I used in this research and the design techniques and tools of those methods and explain their relationships and role. In this research, I focus on exploring the potentials and problems of designing for and towards long-term sustainability in the context of climate change through an overarching methodology of research through design. More specifically, I use speculative research through design inquiry into Life Forms and Life Styles as a mode and venue for exploring ways to address the key challenges outlined above. The research on these challenges focuses on the material, the body, the nonhuman and the environment and their relationships around the two concepts of Life Style and Life Form. Unlike other sociological or cultural studies inquiries concerning ecology or technology, my research examines existing unsustainable cultural phenomena and creates opportunities for sustainable futures through designing. These possibilities are also beyond the limitations of commercial design research and today's hegemonic capitalist framework.

3.1.2 An Interplay Between Theory and Making with Relational Thinking

3.1.2.1 Orientation

This research involves the interplay of design expertise, practice and analysis. This refers to skills and insights from previous professional and educational practice, the composition and embodiment of the design works in this doctoral project and the emerging analytical reframing of the project as the research literature and making activities interfaced with one another. In these processes and their materialisation in design works, peer-reviewed academic

28 *Artifacts from the Pluriverse*; available at: https://designresearch.no/projects/artefacts-from-pluriverse/about.

publications and this exegesis, a number of questions needed to be considered.

First, I was motivated to develop and position an exploratory approach to speculative research through design that draws together and distinguishes ways and means to investigate matters of climate change. Second, I needed to see how to enact that approach in design-based practice enquiries that are situated and poetic but also diffractive and critical. Then, I needed to reflect on the dynamic epistemological relations between designing activities, artefacts and mediation and the emergent re-framing of a critical analytical view that I came to call a Speculative Life-Style-Form Design Perspective schematic (see Chapter 5). Finally, the thesis research as a whole took the form of a diffractive interplay between theory and making. The early research framework is based on connecting theories on Life Form, Life Style, ecology and technology. In the process of making design within that framework, the framework itself was constantly improved. This diffractive framing of the research helped generate a diagramming that was taken up to critically and practically guide and evaluate designs and designing. The design research process was diffractive rather than linear and iterative. In this diffractive process, I researched different fields and disciplines by designing to compare, explore and understand different knowledge for potentials and problems of the future.

The literature reviewed in Chapter 2 addressed Life Styles and Life Forms for sustainable design from multiple and relational perspectives, especially the posthumanist outlook. While work on lifestyles and life forms has been carried out mostly in social sciences and cultural studies and the biosciences, respectively, following Forlano (2017), I position my mode of inquiry in design. However, this requires considerable focus on design research methodologies and methods, as design inquiry has a relatively sparse research literature of its own related to posthumanism. The mode of inquiry I enacted was thus to explore the heuristics of relations for sustainable futures in research by speculatively making and using that work to think through and into relational, nonbinary, futural configurations and dynamics in order to make and reflect on speculative artefacts and their heuristic potential. In this research, I use such a nonbinary methodology to embrace transmethods and multimethods (abductive, poetic, emergent, designerly, situated, qualitative), design and its process designing or different making processes, such as those outlined in *The Routledge Handbook of Interdisciplinary Research Methods* (Lury et al., 2018). These different makings processes could be essential to making the research valuable for the challenges we face today:

> … approaching methods as -ings focuses attention on the pre-posing of problems, that is, it understands the role of methods as ways to activate the spatiotemporal variations, the 'declensions and inflections' of the present. To push this argument a bit further, the presentation of methods as -ings highlights their methodological potential to not only take but also make (space and) time. (Lury, 2018, p. 4)

I do this to understand and build ways to address relationships between humans, nonhumans, culture and the biosphere through exploratory, speculative design dynamics that include

different design materials with varying processes of making, different disciplinary knowledge investigated in the designing process and design outcomes that different perspectives can analyse.

3.1.2.2 A Making-Analytical Practice

I chose multiple speculative design methodologies and methods that are cross-linked to address the importance of materiality and mediation and explore deep structural problems in the context of climate change. This research is based on a relational four-part designing-researching inquiry framework outlined by Morrison, Mainsah and Rygh (2019). It is comprised of research methodologies, research methods, design techniques and design tools. This division seeks to pay more epistemological attention to design research as a 'making-analytical practice', leading to strong links between design methods and critiques.

The methodology in this research adopts research through design with a mixed inquiry mode of speculative, poetic (Markussen and Knutz, 2013), transdisciplinary (Held, 2016; Wilkie, 2018), heuristic (Mazzei, 2014) and diffractive (Barad, 2007; Hill, 2017) inquiry. It constructs future Eco-Cultural-Techno scenarios and accounts through speculative artefacts to research the potential relationships of sustainability. The speculative artefacts integrate with and are analysed by different disciplinary knowledge bases in a diffractive process to produce design-driven knowledge that suggests and perhaps provokes actions and transformations towards rethinking framings and understandings of sustainable futures.

My research methods include speculative making, collaborative making and contextual studies. Speculative making involves a diffractive design process, while collaborative making entails multiple modes of making, including co-writing with supervisors and co-making with engineers. Contextual studies incorporate heuristic process and embodied knowledge through sensory field study (Yelavich, 2014). Different focuses try to build up nondualist research methods (Lykke, 2010; Redström, 2017). I bring in my different design techniques – sketching, drawing, visualisation for communication, making prototypes, writing, mapping and curating – to develop design tools like schematics that help facilitate the research method.

The four parts presented by Morrison, Mainsah and Rygh (2019) cover the two interconnected sides of my research: a mode of academic research and a design mode of inquiry. In design research, specific design methods, techniques and tools are intertwined to generate knowledge. Conceptualising and connecting design research methods are used not only for creation but also for analysis.

The design techniques and tools I used involve sketching, drawing, visualisation for communication and making prototypes (Lury et al., 2018). This research also employed several transdisciplinary inquiry techniques with a design perspective, like essaying, mapping and curating

(Lury et al., 2018). I did this to indicate their relationships, which design tools and techniques can empower research methods and what methods, design techniques and tools I applied in this research.

3.1.2.3 Three Related Parts

These complex and mixed methods were flexibly used at different stages of the research. Generally, my research methods can be divided into three conceptual parts rather than temporal stages: feeling futures, which includes reference and field studies; making futures, which builds up a 'search space' (Bratton, 2016b) through creative making; and expanding futures, which works through further interpretation of and reflections on design objects.

As a poetic and heuristic research inquiry, my three-part research process covers the four-step method of design fiction from Markussen and Knutz (2013). Feeling futures is a way to identify contextual scenarios and create worldviews or rules for the scenarios. Feeling here addresses the embodied knowledge of contextual studies through the designer's sensibility. Making futures includes creating experimental futures by crafting various prototypes of those futures. Here, making refers to designers' special techniques of making things, cooperative making between different experts and the materialisation of futures. My approach moves past the Markussen and Knutz four-step method by using expanding futures as a further analytical process, including exploring additional contexts and scenarios of speculative design artefacts and writing articles with an analytical frame to produce more knowledge in a diffractive mode of knowing.

In Section 3.3, I unpack the roles played by these three parts. Contextual studies in feeling futures include field studies with sensory perspectives and the examination of other designers' work. Making futures is realised through a relational and speculative process of making. Finally, Expanding futures is discussed, along with how to use this publication as practice. Next, I focus on matters of frames and methodology.

3.2 Frames and Methodology

3.2.1. Research Through Design

3.2.1.1 On Research Through Design

In the past 30 years, research through design has been used in different fields and borrowed knowledge and research methods from other mature disciplines such as the social sciences, computer sciences and art. Frayling (1993) proposed a practice-based research perspective in the field of art and design education 30 years ago. He introduced three types of design research: research into design, research for design and research through design. Since then, many design researchers have adopted his concept of design research and combined its different

modes to form a more holistic, practice-based research or research through design.
In the field of interaction design, Fallman (2008) elaborates on research through design by introducing the triangle research model and dividing the design interaction into three methods: design studies, design practice and design exploration[29]. The three research methods can promote one another and, together, develop comprehensive methods for research through design.

3.2.1.2 Methodology for the Research

Koskinen, Binder, and Redström (2008) illustrate three different kinds of research through design: lab, field and gallery[30]. All three modes put the design process and outcome at the core of design research by using different techniques and skills, such as making prototypes and visualisations. Research through design continues to learn from other disciplines to develop new design research methods and mix those methods to form unique design research methods that move beyond the other disciplines.

My doctoral research is focussed on futures and potentials, which makes it close to a mode of art. At the same time, I combine these research modes with the insights and knowledge of posthumanism to form a research methodology through speculative making. Design exploration in Fallman's design research triangle and the gallery design research mode both refer to speculative design research, which I introduced in the previous section.

3.2.1.3 Designing Methods

In the research, I adopted a research methodology of applied, poetic and conjectural inquiry and called it research through speculative making. The world-making in artefacts and installations addresses both the actions of the design process and the design objects of creating results used to generate and discuss knowledge. Bratton (2016b) argues that speculation builds up a 'search space' of research that is always incomplete and neither positive nor negative. For me, research through speculative making is not just about design objects that can be analysed and criticised. It is also about the process in which I put myself into this space full of uncertainties and emerging technologies to search for survivable futures in the context of climate change. In other words, design objects were not my milestones. They are more like a video recorder with an Eco-Cultural-Techno lens to record imaginations, speculations and anticipations through creative making. This is a way to create an open frame or environment that allows sustainable transitions to happen.

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29 Design practice entails that design researchers study specific design practices and participate in those practices, as in some commercial and applied design projects. Design exploration is similar to design practice but is more about generating new ideas; its core content is 'what if?' and includes speculative design research. Design studies examine current knowledge in other fields related to design and existing design cases to create new content that can help design research, such as literature studies and workshops.
30 A lab is used to construct an experiment based on scientific knowledge to test design. Field is used to put the design into a specific situation to test and generate new knowledge that is suitable for verifying existing principles and theories. Gallery is more focussed on the experience and reflection of designed objects and generating knowledge through critical inquiry; it is similar to art-based research.

3.2.2 Research Through Speculative Design

3.2.2.1 On Research Through Speculative Design

Research through speculative design is practice-based research. On the one hand, it is a mode of inquiry aimed at uncovering and imagining possibilities and insights with the hope of envisioning sustainable futures (Ward, 2021). Another aspect is the practice of embracing uncertainty and creating, imagining and materialising new worlds. This research can also examine scientific knowledge and technological innovation's cultural and social values, which could share some theories and research approaches with science and technology studies (Wilkie and Ward, 2009).

The research focuses on exploration, reflection and engagement by creating a new symbolic and existential purpose of things and their systematic function (Malpass, 2017). Designed objects become a kind of abstract imagination through design materialisation like design modelling, design crafts, design fiction and so on. When designed objects become a research process to trigger possibilities and provoke discussions, James Auger (2013) provides important suggestions on the speculative design approach that help manage that speculation in an appreciative way. As to the role of design in the research, the design objects cannot be far from everyday life or too close to everyday life; they need to fully consider their environment and context. A design could be a verisimilitude of a mixed fictional and real world to trigger possibilities and counterfactuals that will provoke discussions.

Practice-based research towards uncertainties and futures shifts method from rational problem-solving to the relational imagining of scenarios (Koskinen et al., 2011). Design in the digital humanities field, which addresses future scenarios of emerging technologies, could be viewed as an emerging tool or unit for shaping arguments when different knowledge from different disciplines cross in a given unit (Burdick et al., 2012). On the other hand, Parisi (2012) addresses relational thought in the speculative method for research:

> [The] speculative method is itself a proposition: neither the result of theories nor of practice, the rational nor the empirical. As a proposition, this method considers the object not as a functional procedure that can be performed everywhere. Similarly, one cannot simply assume that the object always already changes its internal composition according to changing conditions. (p. 240)

3.2.2.2 Nondualist Research Methodology

In my research, design propositions and designs interact with one another. Propositions are the beginning of designs, which can change the method of speculation and the understanding of the original propositions. I connect the knowledge and methods of different disciplines to create possible topics, problems and potentials as an exploratory space or speculative plastic proposition. Thus, the research process is always strategically connecting, creatively making and uncertainly emerging, with methods, design objects and processes influencing one another.

Therefore, my research can be seen as a transdisciplinary, exploratory and emergent mode of inquiry using relational thinking. This research tries to build up a multimodel of inquiry for designing and a multimodel design that can help build up the research model.

Speculation through designing as a research inquiry also offers a posthumanist method to challenge the dualism that is so prevalent in the current research culture. The speculative method 'may qualify as an event (the nexus of actual occasions), a generalised assemblage of logic and aesthetic thoughts able to supersede, interrupt the seamless continuum of cause and effect, method and object' (Parisi, 2012, p. 242). From a posthumanist perspective, speculation through designing may cross science and culture by making as-yet unknown objects to generate nondualist artefacts and related concepts, imaginaries and thoughts in a nondualist methodology.

3.2.2.3 On Prototypes

I have carried out the research methods in the context of the two works developed for the thesis, both of which focus on this special time and the particular character of the global climate crisis. The design scholars Markussen and Knutz (2013) offer a helpful example. They connect poetic inquiry – imaginary, constructionist – with design fiction in design research in interaction design. They use both literary and design practice to enact this research through writing, developing rules of fiction, world-making and prototyping. Designers can use writing to carry out contextual studies. Developing rules of fiction and world-making is a creative way to understand and explore futures. Prototyping, meanwhile, is a performative and symbolic way to reflect, engage with the audience and discuss potential futures.

These prototypes of design fictions become heuristic forms and activities. Design fictions (as also covered in Chapter 2) welcome ambiguity, interpretation and meaning in ways that go beyond conceptualisations and practices of efficient usage (Malpass, 2017). Within qualitative research practices, poetic inquiry also features and may support and motivate creativity, subjective feelings and emotions into research beyond empirical and theoretical studies in the social sciences (Butler-Kisber, 2018). Butler-Kisber uses Hussey's concept of 'heuristic device' to explain the role of poetry in qualitative research. Heuristic devices can help understand and connect themes, discover new materials, shape and structure ideas and communicate with others.

My studies are located in the digital and environmental humanities and design installations. Yet, research through speculative design may be realised together with an assemblage and a combination of diverse methods that involve critical, creative making and applied, situated qualitative social science. I therefore refer to applied approaches from technoscience and futures studies, such as scenarios and foresight sketching (Candy and Dunagan, 2017). I draw on these resources, along with my experience in branding and strategic design, to develop multiply linked methodologies. For example, I took this up in developing aspects of the

characteristics and presence of AI in the LO project.

In this view, my research becomes process-driven, heuristic, transdisciplinary and poetic rather than a linear and iterative process. The heuristic research process goes through different fields and disciplines through speculative making with contextual studies to create problems and potentials on sustainable futures. Poetic inquiry concerns the performance of symbolic speculative objects for further analysis. The transdisciplinary process uses collaborative making and includes making the prototypes with engineers and co-writing with supervisors.

I adopt this research methodology to carry out two related speculative design research projects. I introduce the different methods of the three parts in the following section.

3.3 Research Methods

3.3.1 Introduction

A wide range of linked research methods were taken up in this study. I reviewed literature and commercial and artistic projects on posthumanism, sustainable design, speculative design, my concepts of Life Form and Life Style, and cosmetics in the feeling futures part. These themes are complex and connected and require preparing enough materials to frame speculative design projects, ideation and making processes. Then, I carried out contextual studies of speculative design projects, including field studies, site visits, and interviews. After the feeling futures part, I made speculative prototypes, which was the main research method. Finally, I devised publications to create more knowledge and to reflect on and evaluate the research.

3.3.2 Reviewing the Literature and Related Commercial and Artistic Projects

As shown in Publication 2, I spent time identifying and studying a variety of speculative design projects. I was keen to identify and examine ones that concern human futures, both ecological and technological. These projects focus on care for nonhuman, technological-driven solutions for ecological crises or show the dangers of technology for ecology. These projects are tracked by the mainstream design website *designboom*, the architectural site *Dezeen*, and a posthumanism website[31], all with reference to posthumanism and speculative design[32].

In one way, these cases helped me understand new technologies from a design perspective and

31 Available at: https://criticalposthumanism.net.

32 For example, Neri Oxman tries to use digital and ecological technologies together to imagine and speculate about a new fabrication process of sustainable futures from human cultural perspectives. Another example come from designer Alexandra Daisy Ginsberg, whose works explore the potentials of a 'better' world which could contribute to both human and nonhuman by investigating AI, synthetic biology, biodiversity and so on. Ávila designed a speculative shower gate to create plural metabolic systems between human–home and scorpion–underworld to investigate embodied responsibility relationships between human and nonhuman to rethink human safety issues and crises (Ávila and Ernstson, 2019). More cases are discussed in the publications and Chapter 6.

Figure 3.1 Santa Maria Novella cosmetics shop, 2019 (Photo by Yue Zou).

Figure 3.2 The garden in the Castello Hills, 2019 (Photo by Yue Zou).

guided me to dive deeply into certain specific technologies and science related to my research, like plant intelligence. In another way, I used the concepts of Life Forms and Life Styles to review these cases to analyse their advantages and disadvantages and see whether my designs could combine the three perspectives of ecology, culture and technology. These cases also helped me see how others make and present prototypes and to assess the practical issues of my research projects.

3.3.3 Contextual Studies

The research started with three semesters of contextual studies through literature review writing, contextual mapping and making research plans. This period could be seen as a mode of feeling futures of the overall doctoral project. During this period, I used knowledge and insights to make a design frame which guided the two speculative design research projects. The frame evolved with the research process and became a Speculative Life-Style-Form Design Perspective as a research contribution. Both projects involved research processes that included the three parts of feeling futures, making futures and expanding futures. I introduce these three research methods individually below.

The field studies in this research adopt a poetic, sensory approach, which strengthens the role of the researcher's experience and expands the knowledge generated by the senses. Sensory ethnography, which has been used in the humanities and social sciences, is taken up to study and use senses to explore and examine the environment and world through memory, imagination and improvisation. This imaginative approach makes sensory research one way to engage with futures (Pink, 2010). The kind of sensory findings for my research could provide more diverse materials for further speculative and imaginative designing.

For example, I went to the cosmetics shop Santa Maria Novella in Florence (Figure 3.1) and its garden (Figure 3.2), which grows herbs for its products. This was a way to gain situated and embodied knowledge about ancient and successful localised cosmetics production, sales and use through a multisensory experience. The cosmetics brands have developed more products for modern life and provide online shopping services, even though they still use traditional ways to make their products. When I was in the shop and garden in Florence, the multiple sensorial experience gave me a concrete sense of the value of localisation, which is hard to obtain from text or online, compared with buying the same products in Oslo. In my field study, I also interviewed stakeholders like farmers, local consumers and tourists, etc on their thoughts and feelings on the products after the site visits. Then, this sensory method could serve to bring forth a contemporary feeling based on a historical lifestyle so as to think of alternative Life Styles and provide more comprehensive knowledge for related reflective activities (Schön, 1983) to discuss challenges from emerging technologies and contemporary and even different cultures.

3.3.4 Speculative Making

Generally, making and assembling are transdisciplinary research methods used to create new ideas and integrate knowledge from different disciplines as a research method (Fensham and Heller-Nicholas, 2018). Speculation is a kind of making and assembling, and speculative design is a way of making and assembling by designing for transdisciplinary research (Wilkie, 2018). The making process of the speculative designed artefacts could also create new methods by reconnecting the different materials, contexts and purposes of the designed object(s) (Malpass, 2017; Wilkie, 2018). Based on these different thoughts on methods of making, I called my research method speculative making since making and assembling occupy the most central position in this speculative research. Speculative making in my research includes shaping the design process and artefacts designed through that process. The making process determines designed artefacts, and the speculative artefacts demonstrate the ideas and knowledge generated during the design process, ultimately changing the design process and its outputs.

In my research, I used my designing process to understand the material entanglements of climate change through the different emerging relationships between humans and nonhumans during designing. The diffractive design process here means designing with other theories to make emergent and unpredictable design artefacts, including the physical and fictional, that will lead to differences in the world.

In order to work with a relational and diffractive view and methods (Barad, 2007; Doucet, 2018; Hill, 2017; Mazzei, 2014), I developed a three-part design process: feeling futures, making futures and expanding futures. Feeling futures concerns researching speculative propositions, making futures involves developing research by making design artefacts in an exploratory and diffractive way by using speculative propositions. Expanding futures refers to research centring on analysing the design artefacts, reflecting on speculative propositions and expanding propositions for more possibilities and problems.

This model can also be read as a means to charting some of the diffractive aspects of the processes of designing used in the study. Feeling futures builds up an original space of possibilities based on a theme or proposition, while making futures offers more possibilities in material entanglements and relationships for differences to expand and rethink that theme of proposition. New propositions create more space for possibilities beyond, interacting with and related to the space of feeling futures, which can be positive, negative or plural. These new possibilities of material entanglements and relationships can be regarded as a relational implementation of the transdisciplinary to gain a more mutual and transformative understanding of the theme or proposition to expanding futures.

In this research, speculative making as a nondualist method generates artefacts of various material entanglements and relationships. The artefacts are sketches, digital illustrations,

scenario posters, schematics, demonstrative functional models and so on. Artefacts can be physical and digital, scientific and fictional, functional prototypes and demonstrative illustrations. Speculative making with various artefacts can use unrestricted methods to understand existing, emerging and latent knowledge and creatively imagine and speculate about more possibilities by playing with different design materials. In this way, this method provides an opportunity to review the new cultures produced by design that cannot be reached by existing technology and existing cultures that cannot adapt to emerging technologies in the context of climate change.

3.3.5 Publications as Practice-Based Research

For some scholars, publications can be an evaluation method and take the form of both articles and exhibition websites that can be distributed and accessed in various forms (Morrison, 2017; Vaughan, 2017). In this doctoral research, each design research project corresponds to a publication. In my research, publication as an evaluation method includes my writing process and the publication itself as a complete design argument for further exploration and discussion. With publication as a filter, exemplification in my research can also be seen as a critical intervention (Gilbert, 2016) to show the complexity, paradox and potentials of sustainable futures towards the climate crisis for other designers and experts for additional actions and changes. Most artists and scholars use publications not only to express their ideas and emotions about the current human crisis but also as a discussion space for different audiences to join in and take further actions. I use my publications to analyse and problematise my design works and rethink the overall design work to change the propositions of my research project and build up a foundation for future projects.

In my research, I mixed different methods, integrated different design techniques with those methods and created design tools to implement those methods. In the next section, I introduce the design expertise, techniques and tools I used.

3.4 Design Expertise, Techniques and Tools

3.4.1 Introduction

In this research, I use different design expertise, techniques and tools based on my own study and work experience, which refers to basic design skills like sketching and drawing, making physical and digital prototypes and visualisation for communication. I earned an undergraduate degree in industrial design with a focus on sustainability. Since graduating, I have worked on a diverse range of design projects, especially in strategic design involving sustainability. My expertise includes making physical and digital design prototypes and carrying out trend studies of emerging technology and culture.

Figure 3.3 Future Dialogues Now exhibition during Stockholm Design Week 2019 (Photo by Yue Zou).

During this doctoral journey, I engaged in a process of learning to be a designer-researcher in which I needed to use my design and research abilities based on my experience through designing and co-writing research. The network-based project designBRICS provided me with cooperative opportunities at a global level to carry out field studies, make prototypes and attend international conferences. This research involved many different stakeholders in both Norway and China. The contextual studies method, the two speculative design research projects and the publication writing all used different design techniques, as discussed in the previous section. Next, I introduce the design techniques and tools I used in detail in two categories – design cooperation and design prototyping – and present an overview of the doctoral research process.

3.4.2 Design Cooperations

One of the design cooperations involved discussing my literature review with master's students during a design course that also dealt with climate change. I gained further insights into the content of my research while curating an exhibition called Future Dialogues Now during Stockholm Design Week in 2019 (Figure 3.3). This exhibition had two spaces. One was in the main exhibition space; the other was in an innovative co-working place. The exhibition idea presented futures in both physical and digital modes to demonstrate nondualist ideas. I designed the exhibition formats and made the exhibition brochures with students. This design cooperation with students offered ways to analyse and advance research on the knowledge generated in the contextual studies.

During the XIANGVEI and LO projects that I later developed, various forms of cooperation in making prototypes helped advance the conceptualisation of design concepts for the works (Koskinen et al., 2011). A range of cooperations between designers and engineers in China and Norway supported both ideation and evaluation through iterative processes between the design and prototyping processes. I thus adopted a flexible way of collaborating with different teams in the early stages of conceptualisation and prototyping. In addition, I was able to participate in, contribute to and discuss my works at the ReFuturing Studio at AHO (see Chapters 1 and 2). I also discussed early conceptual sketchings and drafts with more than 10 designers and researchers with similar design interests in futures, climate change and sustainability. Later, I discussed my concepts with practical designers in the cosmetics industry through my private network in China, France, South Korea and the United States. These discussions extended to three flexible and informal workshops: one was in person in China, and the other two hybrid and online.

The central goal of this research has always been to explore a diverse cultural understanding of sustainable futures. I chose to do this research in both China and Norway as a Chinese student undertaking doctoral research in Norway. China is the world's largest production centre; I wanted to take my speculative design, which is influenced by posthumanism from Western

culture, my thoughts in Norway and my own cultural referents from China and cooperate with Chinese manufacturers to build actual artefacts of high production quality. In this way, I planned to use a globally connected speculative design artefact-making process to understand some of the core relationships between my design ideas, future technological production and different regions' views on sustainable futures in the context of climate change.

In this process, I needed to find a suitable producer. I first communicated with different practical designers in Norway and China. Then, I conducted face-to-face and onsite non-structured interviews with five companies in China that I accessed through professional and research contacts at Hunan University. These included Farsoon Technologies, China's largest 3D printer manufacturer, the robot company Ubtech and the 3D printer manufacturer Sanwen.

In the process, I found a Shenzhen company, Sanwen Technology. Sanwen is located next to Ubtech, a leading company in Shenzhen that makes customised 3D printers for business. Sanwen also customises and produces diverse smart products such as robots. By establishing collaborations with these two adjacent firms, I was able to carry out the different but connected XIANGVEI and LO projects in the same place. Further, it was possible to develop a flexible creative process when compared with business-to-customer companies that develop refined, complete products rather than the flexible prototypes. I cooperated with Sanwen to make a functional and demonstrative model and develop a relatively complete design model. Most of the designs I developed with Sanwen were completed by me independently. As a cooperating partner company, Sanwen provided 3D printing and technical components, code implementation and other technical support needed in the manufacturing process. They did so in iterative dialogues with me.

The different kinds of design cooperations noted above were interspersed through the entire research process and helped diversify my understanding of my design concepts due to their being situated in different cultural, academic and commercial settings. The cooperation in the prototyping process, as outlined in the next subsection, also helped me understand the current application of new technologies in design and to explore what kind of prototypes might become a 'search space' in the wider design processes and productions.

3.4.3 Design Prototyping

Different speculative prototypes were developed through making in the XIANGVEI and LO projects. They may be viewed as design models and tools made of different materials. Each prototyping process included conceptualisation, sketching, drafting, making, trialling, implementation and reviewing. Here, I introduce important design techniques to show how I made the two prototypes in my research. I explain and analyse the role of these design techniques in my speculative design research.

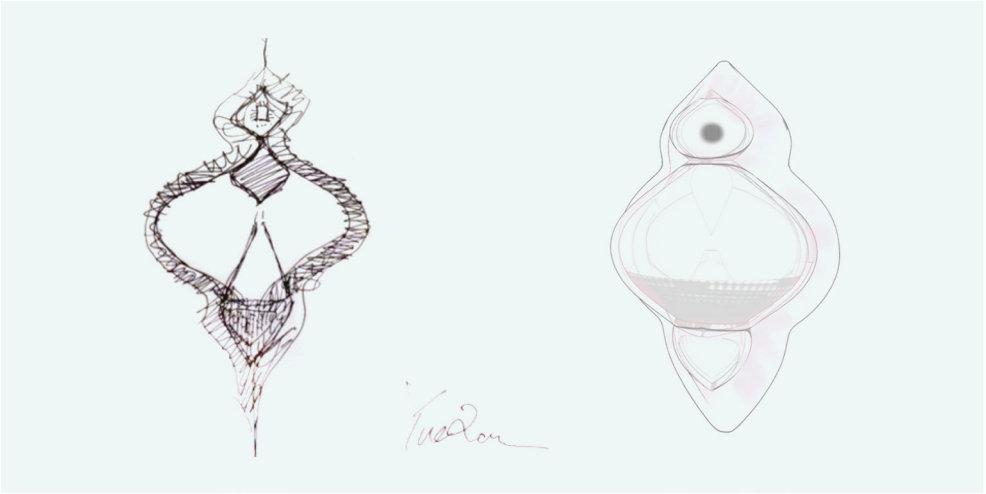


Figure 3.4 The first organic design proposal of the XIANGVEI project for bioprinting (Zou, 2019).

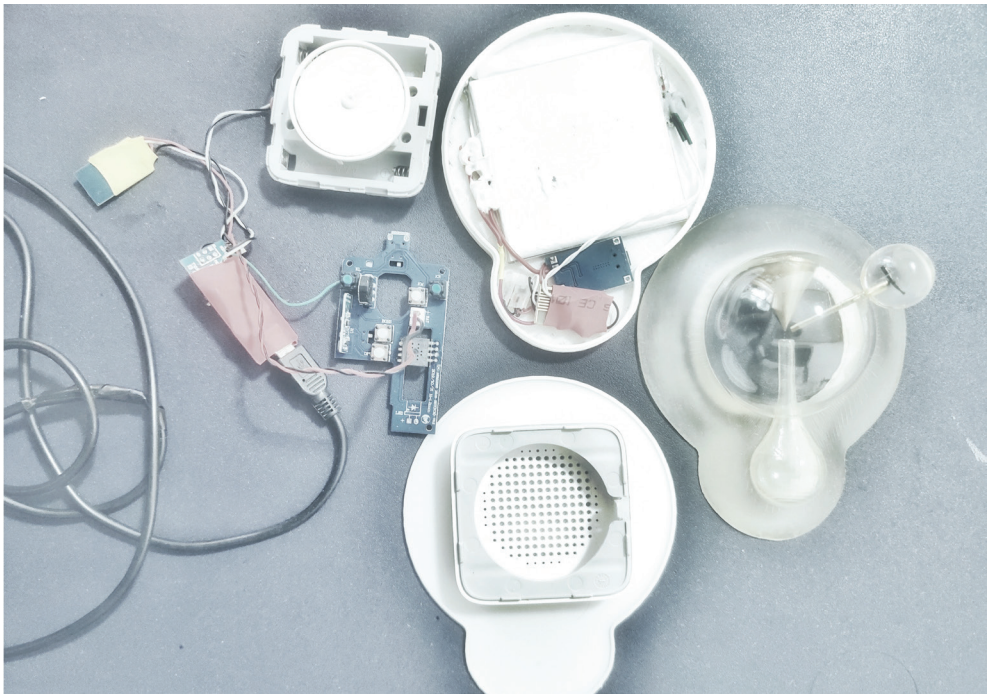


Figure 3.5 In an experimental making process, the technical components of the installation simulated the experience of XIANGVEI (Zou, 2019).

The materialisation in this speculative research was a way to blur material and conceptual boundaries to abstract technology and explore both the technological and cultural potentials of technologies (Malpass, 2017). The materialisation also plays a medium (of the kind one would find in biological research) in making an interesting and accessible crystal device to expand possibilities, enable discussions and envision futures. The materialisation made futures that are valuable today:

> When inserting the future in the crannies of the present designers are taking future specks to grow the present as a crystal in the material medium and environment that already resonate with future and present possibilities. Speculative Hardware is one such irritant, inserting itself as an outcast from the future in the middle of a present that becomes itself only once it has adjusted its medium to allow the future to resonate. The other line we need to bring back into this moment is the pragmatic. (Brassett, 2016, p. 173)

The process of materialisation through design offers a way to think about futures. In this case, different design techniques can provide different analytical perspectives to understand these futures.

3.4.3.1 Designing Prototypes for XIANGVEI

The conceptualisation process of the XIANGVEI project mainly involved Life Styles and the potentials of human enhancement from a cultural perspective. Therefore, the project started by reimagining perfume in everyday life beyond contemporary scent culture and human enhancement technology. Then, the exploration of materiality became the possible connection between scent and human enhancement by making a unique scent device composed of materials unprecedented for such use by humans. Making in this project meant 'investigating what a potential future might be' (Zimmerman, Stolterman and Forlizzi, 2010). During the prototyping process, I studied much current 3D printing technology, from complex metal printing to the latest bioprinting technology, for tissues with Sanwen Shenzhen. I visited four different 3D printing plants in Changsha and Shenzhen for both the business-to-business to business-to-customer markets. There, I discussed the potentials of 3D printing for sustainability. Making some potential prototyping plans increased my understanding of bioprinting and its future scenarios and provoked new ideas about XIANGVEI as a human organ and a cosmetic product.

During the implementation of prototypes, the design of bioprinting was planned to be the first design prototype with a high-tech and organic feeling (Figure 3.4). However, I abandoned the goal of making the prototype through bioprinting, because it could not make a full-size XIANGVEI product, and the design could not be used as a 'heuristics device' (Butler-Kisber, 2018) to stimulate more thoughts on scent; it could only be a technological application demonstration. In line with a device that can generate embodied knowledge, I chose to make a simple interactive installation (Figure 3.5) as a design outcome to simulate the XIANGVEI sensory experience with a fine silicon model of the XIANGVEI organ. The details of the installation

can be found in Publication 2.

In making the interactive installation, the engineers I cooperated with appreciated that XIANGVEI as a human organ could also be a form of perfume. However, they could not understand my concept when we focussed only on bioprinting applications in the beginning. Making this installation reflected the potentials and problems of bioprinting. In another prototyping process, I used a simple digital poster as a poetic method to create design fictions involving XIANGVEI scenarios. Here, I did not use detailed storyboards or videos to convey stories. The writing and digital illustrations on the poster were used to sort out the knowledge generated in the research and prepare for the writing that was to follow. Compared with videos, the poster could use fewer symbols, adding more challenges to this complicated cultural research.

3.4.3.2 Designing Prototypes for LO

In this project, I was trying to design alternative skincare products to explore the future human Life Style and address ecological flourishing by building new relationships between humans and nonhumans. This process began with making LO, a physical functional demonstrative AI, and ended with new scenarios and stories of the ecological system (see Publication 3). I conceptualised the design in Oslo and made the functional prototypes in Shenzhen. The scenarios were developed through the co-writing process of the third publication.

The prototyping process and the LO design techniques were not the same as those used for XIANGVEI. The conceptualisation of LO put more emphasis on Life Form. In its conceptualisation, I studied emerging high-tech cosmetics from leading global cosmetics companies like the L'Oréal Group and the Shiseido Group. I gained a general knowledge of using cutting-edge technologies in the cosmetics industry by devising a map (Figure 3.6). I followed the mapping method described by Sevaldson (2011) in which a systematic method developed for design is termed GIGA-mapping and includes design techniques like visualisation to examine relationships between seemingly disparate categories and apply border critiques to the conceptualisation and framing of systems. The map I devised focuses on Life Form and Life Style and classifies high-tech cosmetics into two groups: human enhancement related to Life Forms and certain AI technologies related to Life Styles like the Internet of Things. The map's goal was to build up a sense of high-tech cosmetics on the markets and may help later research to think alternatively.

When critiques of high-tech cosmetics and new cultures about cosmetics are hard to grasp, prototyping as a method becomes a way of cultural fabrication to reveal new cultural phenomena and their critiques by 'creating a situation or circumstance' of speculative prototypes (Wensveen and Matthews, 2014, p. 275). When speculatively prototyping the LO, I considered the use of materials, the ways of making and the degree of completion for the LO artefacts.

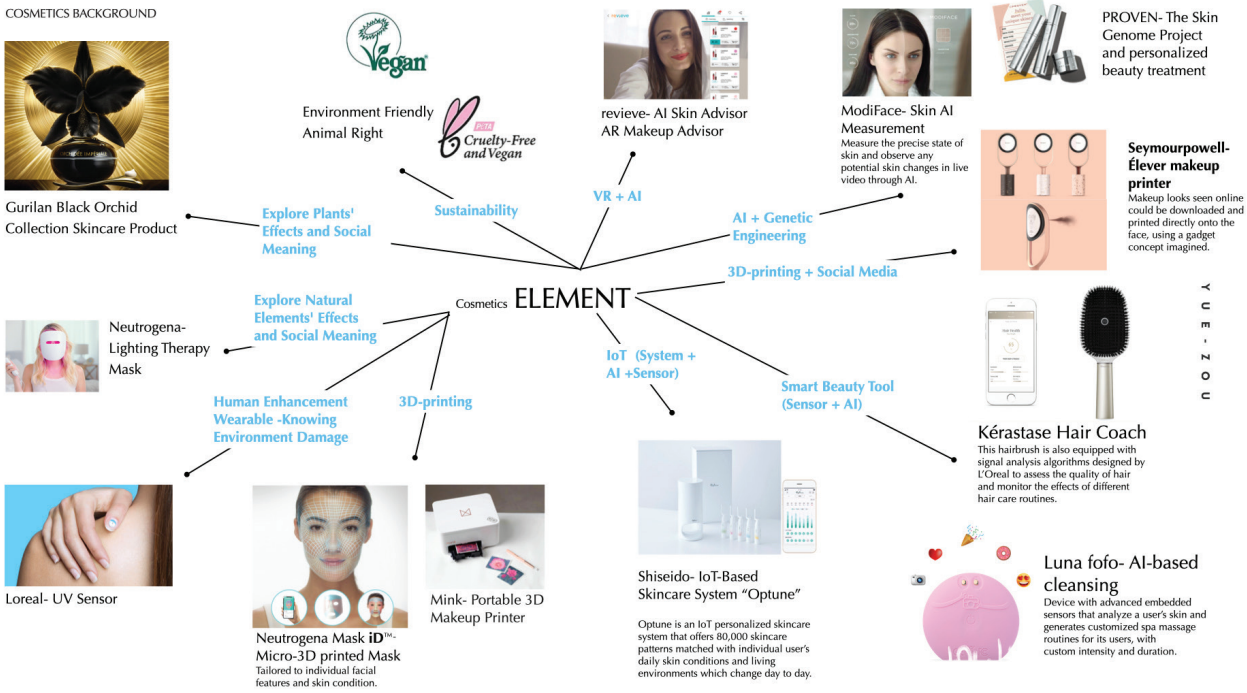


Figure 3.6 Mapping emerging cosmetics products by global cosmetics companies (Zou, 2019).

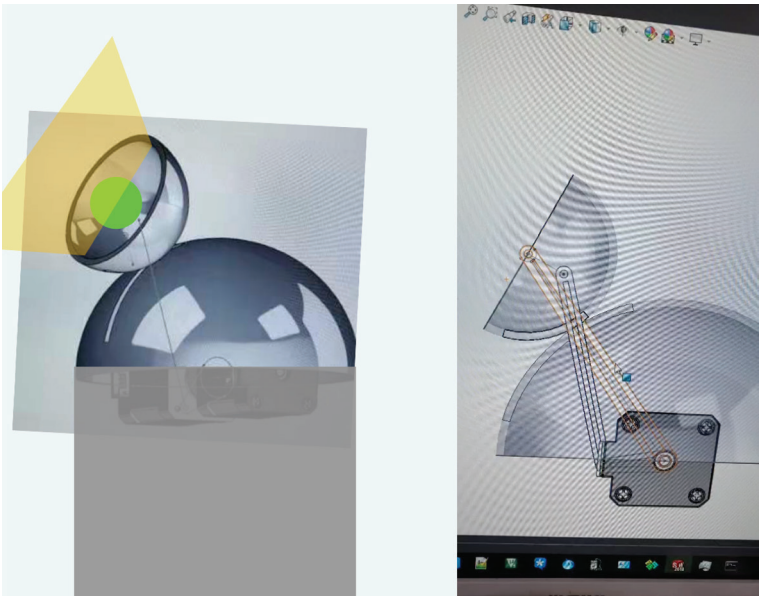


Figure 3.7 I explored the aesthetics of LO's form and movement through digital modelling (Zou, 2020).

These considerations would work to turn LO into a verisimilitude device, to use Auger's (2013) term, that provides the audience with a feeling familiar from everyday life to provoke exploration and discussion within experienced, expected and prospective Life Styles. The LO prototype used an ambient aesthetic style to conceal potential alienation in high technology or the sense of alien life beyond everyday experience (Figure 3.7). This prototyping strategy returned LO to a nonbinary consideration of culture and technology rather than a fancy functional application of high technology as a mode of futures prototyping and promotion of techno-everyday living and style.

Further, as a physical prototype, LO needed to help audiences to curiously and even critically engage in the unfamiliar scenarios designed with LO prototypes. For example, LO needed to be seen as a creature that could communicate with humans and nonhumans in daily life. Together, these reasons led me to make LO in its final functional form and its components (Figure 3.8): I chose to make a demonstrative and functional model that can recognise fixed creatures and emit different kinds of light.

Due to the Covid-19 situation, I could not go to Shenzhen to do the prototyping with the engineers and needed to use video to join the process online (Figure 3.9). This situation led me to focus more on the design idea by brainstorming more LO scenarios and discussing them online with a number of experts. For example, I dove more deeply into what kind of plants or animals to choose in possible future LO scenarios that could contribute to sustainable futures through reading more references and conducting online interviews with biologists. This investigation offered more knowledge to build up scenarios (Figure 3.10) and later analyse design works.

I also developed digital illustrations of LO as digital prototypes to communicate with the technical collaborators about the short- and long-term futures and applied reality of LO. As a result, I was able to position the work so that hybrid prototypes could reflect a variety of speculative scenarios that could offer more search space beyond current and future dualisms between culture and technology.

3.4.4 Connecting Multiple Perspectives, Methods and Making

The speculative making processes outlined above encompassed different disciplinary and practice domains and their overlaps and intersections: design, art, humanities, computer sciences and biological sciences. They were also connected to different worldviews from East and West related to nondualism and non-anthropocentrism in research on plural sustainable futures in the context of climate change.

XIANGVEI opens avenues for future technology to enhance human biology and living, while the application of 3D printing allows us to think of how we shape our Life Forms to address problems and potential directions in sustainable futures. LO introduced ways of working in a

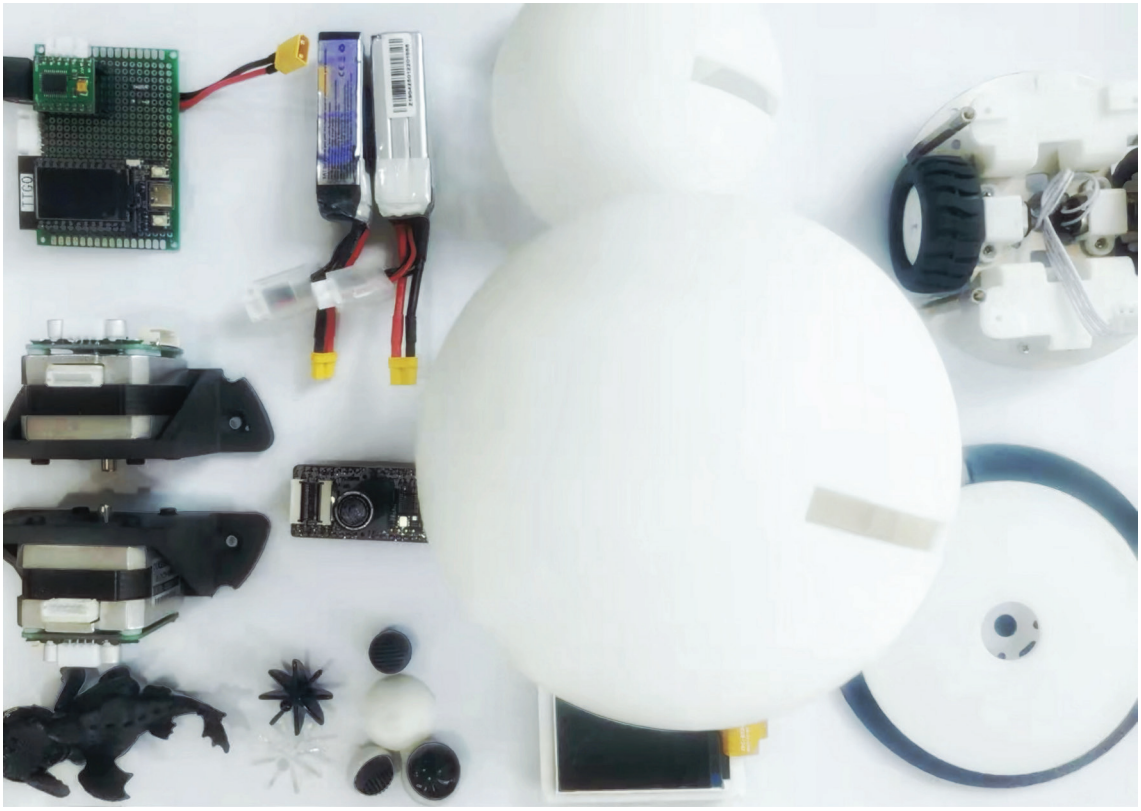


Figure 3.8 The functional form and components of LO (Zou, 2020).

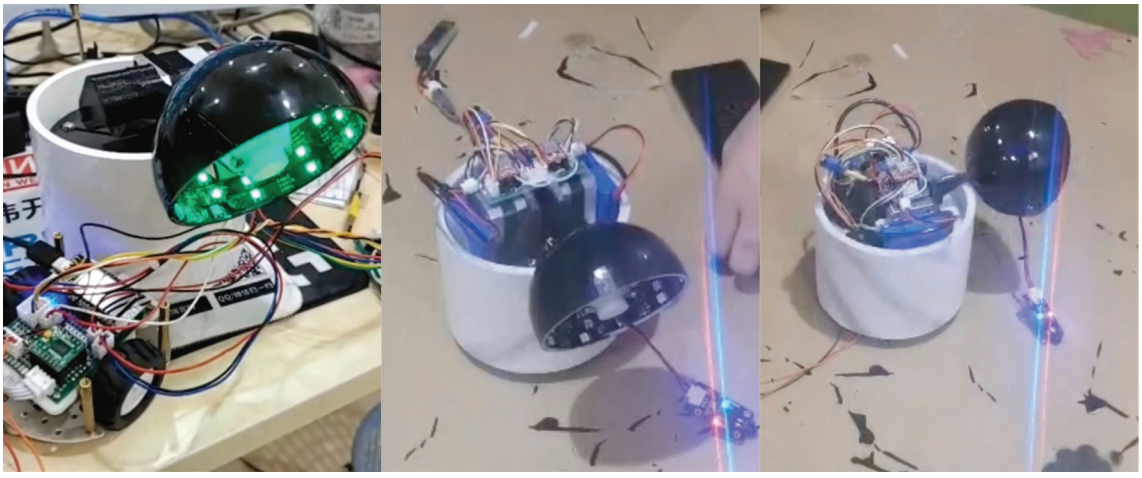


Figure 3.9 The prototyping process for functional product, captured through a phone video (Zou, 2020).

Figure 3.10 I tested LO's visual sensor in a natural environment to learn more about the possibilities of LO's interactions with others, exhibitions and implementations (Zou, 2020).

fresh relationship between humans and nonhumans from an ecological viewpoint linked with conversations with robot companies during the creative process. This project speculated on humans' future Life Styles and explored what kind of smart products may be developed in the future to better serve nature. These discoveries and insights were produced during the process of making; I discuss them further in my publications and in Chapter 6. Finally, speculative making between Norway and China and with collaborators was a way to use futures notions, materials and techno-cultural imaginaries as design materials to discover the problems and potentials of multiple perspectives in the context of climate change.

3.4.5 Schematic Diagram as Prototype

I drew schematic diagrams at different stages from the earlier contextual studies to create the Approach and Perspective schematics I ultimately developed. As a result, schematics played different roles at different stages: guide (initial research frame), brainstorming tool, evaluation tool, data collection tool and so on. In the beginning, I used schematic diagrams to connect knowledge from the literature review through the mapping method. The schematics then became a brainstorming map that recorded and connected research insights and design concepts.

Analytically, I have developed two schematics (see Chapters 4 and 5) to abstract my conceptual thinking and reflections in the Eco-Cultural-Techno Design Speculative Approach and the Speculative Life-Style-Form Design Perspective. The Approach schematic was created to elaborate complicated elements related to my design approach from a broad outlook, and the Perspective schematic was used to elaborate an analytical design frame that has the potential to evaluate the design concept and research findings according to the prompts in the diagrams (Gansterer, 2011). These prompts were lines, arrows, colours or words that guided, provoked and inspired makers and users to continue to dig into possibilities. In my research, I developed a flat but multi-relational schematic because of the complicated elements in my work, all of which are connected and dynamic.

3.5 Reflections and Limitations

3.5.1 On 'inventive methods'

In this section, I offer some reflections on limitations and methods. I do so here to keep these arguments connected to the methodological and designerly means of realising the study (see also Chapter 6). My research uses a mix of methodologies and design methods, techniques and tools. I now briefly reflect on two aspects of the project, making and researching: inventive methods and qualitative inquiry.

First, while I take these up in shaping a relational view on making, my research also draws on what have been characterised as 'inventive methods' (Lury and Wakeford, 2012). They are an important part of working with the dilemmas, challenges and complexities of designing for

sustainable, long-term futures in the context of climate change and the Anthropocene. Lury and Wakeford (2012) see the inventiveness of methods in two situations and their relationships between design and its methods:

> The addressing of a method – an anecdote, a probe, a category – to a specific problem, and the capacity of what emerges in the use of that method to change the problem. It is this combination, we suggest, that makes a method answerable to its problem, and provides the basis of its self-displacing movement, its inventiveness, although the likelihood of that inventiveness can never be known in advance of a specific use. (p. 7)

In my inquiries, imaginary and speculative making were used as inventive methods to open a space for dialogue for care about futures and productively engage with climate change related to my themes. My research neither can nor needs to solve all sustainable and ecological challenges; it focuses on potential relationships between technology, culture and ecology towards ecological flourishing, creating an atmosphere for sustainable transitions rather than giving direct solutions to wicked problems.

New problems encountered in the making process may help us reconsider the propositions of the design research problem and its design ideas and find new possibilities in expanding the scope of the problem, as Barad argues (2007). For example, when making LO, a cosmetics tool for humans and nonhumans, I realised that it could work as a kind of cooperative agent to build and link relationships between humans, nonhumans and itself beyond anthropocentrism and consumerist Life Styles. This points to a problem of sustainable futures being difficult to achieve due to the absence of a widespread cooperative culture.

The research questions recall the need to continue to work to establish a cooperative culture of unpacking the potential of research through speculative design. Further research questions could take up the research presented here and develop and position new methods that may address changing existing products in the present while making potential products for future eco-sustainable circular markets and their critical elaboration and contribution to future cultural economies, Life Styles and Life Forms (Jongerius and Schouwenberg, 2018). This study is located in a speculative design sphere that seeks to open possible spaces and epistemic artefacts. There is clearly room for inquiry that takes this into situated use, participation and responses for both audiences and users (Kerridge, 2016).

Second, the uptake of qualitative research methods asks that we engage in their dynamics, diffractive character and relations to knowing through designing and researching through design (Lury et al., 2018). The immediacy of the climate crisis and arguments about the forces of neocolonialism and neoliberal marketeering (Haraway, 2015) ask that we are careful and critical about the modes and means of our qualitative inquiry, regardless of our poetic and performative stances and their richness (Lury and Wakeford, 2012).

3.5.2 Limitations

Since my research project locates the research field in relation to, if not within, the cosmetics industry, one limitation I encountered in terms of methods was that there are few scholars and academic journals focussed squarely on cultural studies and design practice. I found this to be one challenge of situating my work as a practice and connecting it within and through multiple (inventive) methods that span the humanities and social sciences and through designing. In the processes of design exploration, the choice of topics sometimes limits multiple interpretations to support a qualitative study. In this research, which is focussed on designer exploration, multiple forms of rigour means that I compared marginal and special perspectives with some design rigour in theory and practice and the relations between the two and concerning existing and emerging perspectives to achieve a criticality informed by and hopefully articulated by a multiplicity of ways of knowing and communicating its relationality.

The qualitative, heuristic and poetic mixed methods used in this research as a diffractive practice focuses on the intersection of methods within existing research methods and design techniques. At the same time, this doctoral research opens the door to further sufficiently interdisciplinary cooperation integrated with more methods that I could not tackle within the scope of this effort. For example, LO opens a way to study the biological effects and cultural meanings of light. Further research could use Big Data to study light quantitatively and examine the broad relationship between humans and nonhumans and from the two layers of biological system and cultural system. This could be a large-scale transdisciplinary study on light or may relate to a more extensive study on the solar at a planetary level.

For the XIANGVEI project, I studied scent from different perspectives, and scent or smell is a large research area in biological and cultural research. Food design has also researched taste and smell. In imaginary sustainable futures, the research questions may become how we consume scent ecologically. Further research may incorporate the diversity of the olfactory in the environment (as addressed in the literature in Publication 2), investigating its potential biological effects and cultural meanings and how they may contribute to sustainable futures.

3.6 Chapter Conclusion

In this chapter, I argue that research through speculative design may form a relational and diffractive approach to engage with current and longer-term climate crisis through design-focussed making. As a core method in my research, speculative design evolved with prototypes, mapping and diagramming based on different design techniques and tools. Making here addresses how we respond to the uncertain future and design's unique role in creating alternatives beyond our current challenges.

In this research, I have completed two design research projects. The design methods of both used contextual studies (literature review, field study and case study), speculative making (prototypes, mapping and schematics), and publications. Through this exegesis, the research as a whole covers practice and analysis and connects these practices and analyses as a relational application. As relational research, the outcome of this study connects different kinds of embodied and embedded knowledge from contextual studies and speculative making to form an analytical approach and perspective (see Chapters 4 and 5).

Through speculative design, the main goal of the research was to connect different kinds of knowledge and to use design to foreground these connections from a design perspective through making. To create alternatives beyond the current model of consumerism and capitalism, the inventive designing method can provide a playful and even quirky way to challenge consumerist cultures through designers' special techniques to make different physical and engaged formats and material prototypes. Furthermore, the diffractive process of the two design research projects contributed to the design objects being different by rethinking and exploring new relationships between complex agencies and aspects.

In the next chapter, I draw on these methods and means as part of the framing of the Eco-Cultural-Techno Design Speculative Approach and a related schematic I devised. Then, in Chapter 5, I extend this framing into an application of the Approach, a Speculative Life-Style-Form Design Perspective.

4. Towards an Eco-Cultural-Techno Design Speculative Approach

4.1 Introduction

To counter and challenge the dominant market-driven and computer-depicted visions of the future and uncritical models of economic growth, I have adopted a speculative and heuristic mode of inquiry within a posthumanist perspective (Ferrando, 2013; Forlano, 2017) situated in a relational ontology (Barad, 2007; Bogost, 2012; Walsh et al., 2021). I have done so to explore and position alternative views on making, shaping, analysing and understanding futures, imaginatively and conceptually, as a complex of intertwined relations between the human and the nonhuman. In response, I have offered designs and analyses that argue for the potential of designers' creativity and of speculative design inquiry and analysis as contributions to the intersections of the ecological, cultural and technical for durable sustainability.

In this chapter, I pursue futures design from a posthumanism view as conceptualised relationality when investigating speculative and anticipatory design futures (Celi and Morrison, 2017; Auger, Hanna and Mitrović, 2021) and their potential influence on the ongoing ecological crisis and wider societal uncertainty, such as the Covid-19 pandemic. To make sense of them and to design in such contexts, we have to 'stay with the trouble' (Haraway, 2016) and work towards a narrative of hope as a kind of social resilience (Folke et al., 2021). Below, the research frames new relationships, as new futural assemblages through making (Latour, 2005; Parisi, 2012) for ecological flourishing between human, nonhuman, technology, culture and ecology.

This chapter presents a theoretical framing that I call an Eco-Cultural-Techno Design Speculative Approach which is realised by contextual studies, two design projects, their publications and related schematics. In the context of climate change and long-term sustainable futures, this Approach has been developed as a means to address the complex characteristics, issues and dynamics of design inquiry through speculative making and research. Ontologically, the Approach is relational; pragmatically, it has been developed and informed by acts and processes of designing (see Chapter 3). In terms of making a novel contribution to knowledge, this Approach gathers its three main themes of ecology, culture and technology in a relational framing that is specifically oriented towards design and positioned within speculative designing. In addition, each theme, taken up separately and connected in other research, is positioned within a design view that selects aspects from inside each theme.

A number of points of departure for this work, as charted in gaps and opportunities in the

literature review in Chapter 2, help position the novelty of the inquiry. For example, Forlano (2017) outlines the potential contributions of posthumanism for design and lists core aspects that may need consideration and watchfulness, but Forlano does not cover projects or methods. Further, Ávila (2019, 2021) focuses on speculative making and environmental relations and cohabitation of multispecies and the city from n a human cultural and less technological viewpoint. When looking to critical takes on technologies (e.g., Feenberg, 2017), the focus tends often to be more on culture and less on the environment. These generalisations are made to point to that there is ample room for a design-informed analytical and relational framing of these views.

In Chapter 5, I use the Approach to a focus more specifically on a design view on Life Style and Life Form. To do this, I develop an additional conceptual framing that I call a Speculative Life-Style-Form Design Perspective. The Approach and Perspective are interrelated and work to support the understanding of complex, sustainable and unsustainable relationships at the micro and macro levels and provide relational design perspectives to speculatively think with, by and for new relationships to raise alternative designs for sustainable change.

Next, I turn to some of the contexts of the Approach and its Eco-Cultural-Techno settings and complexities.

4.2 Building the Context for the Eco-Cultural-Techno Design Speculative Approach

4.2.1 Making Relationalities between the Eco-Cultural-Techno

Making connections between ecology, culture and technology is necessary when discussing sustainable futures and dealing with climate change in a relational view. However, the complexity involved in making, understanding and using these aspects and their relations may be one reason why few studies consider them together. Speculative design research can provide an experimental mode of thinking and making to help fill this gap (Auger, Hanna and Mitrović, 2021).

In my Approach, a posthumanist and relational ontological view on Eco-Cultural-Techno futures involves a variety of direct and indirect intersections, connections and relations between, within and across a number of elements and dynamics. In summary, these include a relational ontological frame within which to consider further ways of re-futuring via speculative design, the positioning of a culture of nondualism between human and nonhuman in design imaginaries, reconfiguring research in an approach that sees futures as plural (both human and nonhuman), a frame to critically reposition aspects of future consumerism that is located in more sustainable practices and policies rather than limitless growth, an understanding that technology and design relations need to be critically appreciated in non-determinist and nonbinary

ways, and an acknowledgement of the importance of experiential and embodied knowledge and participation by human and nonhuman actors.

Next, I elaborate on the three aspects by connecting different perspectives from my literature review and the two design research projects.

4.2.2 Three Intersecting Aspects

4.2.2.1 An Ecological View

From the ecological perspective in the Approach, I emphasise a number of key points to connect ecology, culture and technology. First, the ecological view covers Guattari's three ecological views (2000) from the mental to social to environmental. From a mental ecological view, designing in my research emphasises the importance of the physical materialisation process of transforming Life Forms, such as the human enhancement process, which could influence an individual's wellbeing (Oosterlaken, 2009; van den Hoven, 2012). The design process needs to consider natural resources, biological conditions and environments as a whole (Orr, 2004; Wahl, 2016) from the environmental ecological perspective. Ávila, Carpenter and Mazé (2010) have built a model of 3Ecologies to unpack and analyse future design potentials and reach beyond mainstream product design through individual activities, social relationships and local environmental costs and benefits. It covers Life Styles and ethical and globalisation issues. As noted in Chapter 2, this is a multi-perspective device for conveying and making sense of product and speculative lifecycle(s) and their various systemic influences and contexts.

Posthumanists' ecological view also emphasises the wholeness that sees physical and digital (Parikka, 2010) as not opposed and embodied knowledge as essential (Braidotti, 2013). It is about creating a culture of equality between nature and human beings. This goes beyond protection or restoration, such as recycling materials, and finds a way to change for survivable human futures. Ávila (2019) also argues for a relational ecological view as posthumanist intersections between human and nonhuman. Posthumanist thoughts on ecological crises move ecological design to an imaginative and creative approach to envision plural futures, dealing with real and concrete environmental problems rather than imagining a perfect ecosystem (Kallipoliti, 2018). Mainstream Western-centric culture makes us forget that we are part of ecology (Forlano, 2017; Morton, 2018) and that design itself is ecological. On one hand, ecological design emphasises the connection of science and culture to create new designs that can change the disharmonious relationship between humans and nature (Orr, 2004). On the other, it underlines those uncertainties of human futures that require design to explore plural posthuman futures where humans and nature are of equal standing (Kallipoliti, 2018).

From a social ecological perspective, a design focus on Life Style emphasises relationships created by changes in Life Forms through design. A social ecological view focuses on what culture

will be produced by the interaction of these relationships (Jensen, 2007; Ávila et al., 2010) and whether these cultures will be conducive to the establishment of ecological flourishing. This idea suggests that we pay more attention to ecological flourishing, which is a sustainable development process that considers the wellbeing of humans and the wider ecology together (Ehrenfeld and Hoffman, 2013). This new perspective challenges a human-centred sustainable design perspective. In my research, I have taken this up by working with a research through design approach in which speculative inquiry has been adopted and explored to tease out the wider relations of a non-human-centred design approach towards ecological flourishing and long-term sustainability.

4.2.2.2 A Cultural View

Climate change is altering our present and our future, and we now need a long-term, future-oriented way of looking at the present and making decisions that change – and secure – our future. Alternative but situated futures, in the plural (Escobar, 2018; Sardar, 2013), have become cultural sites for reconsidering and exploring sustainable and ecological design so that we might reconceptualise and discuss the shifting possibilities and the problems we already encounter, but also ones we have may not have thought about or at least thought through substantially. Posing and investigating plural futures offers diverse ways to address environmental, technological, economic and cultural challenges between North and South and the disharmony between hu-mans and nonhumans (Escobar, 2018; Fry, 2017). Plural futures offer the possibility of designing across multiple dualities.

The cultural perspective here is located in the development and study of Life Style research and practice. From a postmodern view, Life Style describes and analyses the relationship between people to study social and cultural structures through value, identity, desire and affect (Johansson, 1994). For sustainable research, Life Style has different levels: individual, subculture, country, and the Global North and South. For individuals, Life Style is about achieving value and self-identity through consumption. A subculture is the collective route of a group of people based on specific values (Jensen, 2007). With relational thinking, Life Styles at different levels play their own roles in expressing individual or collective values. In my view, design may further consider the relationships between individual and collective values to facilitate an atmosphere for sustainable movement.

Furthermore, posthumanism leads us to discuss AI culture, the relationship between humans and nonhumans and the value and identity of interaction with AI (Haraway, 2007), which may be viewed as a posthuman Life Style. Culture exists in Life Styles through the values and identities generated by various relationships between humans and nonhumans. I argue that this posthumanist cultural view may be taken up to analyse the emerging relationships of speculative design artefacts in unique contextual settings and to discuss alternative and sustainable futures.

4.2.2.3 A Technological View

In the face of the complexity and extent of the ongoing ecological crisis, we need a combination of technological and cultural approaches rather than a single approach. On the one hand, we have developed low-carbon technologies for renewable materials and applied them to sustainable design. Still, we have ignored the excessive consumption caused by current consumerism (Elhacham et al., 2020). On the other hand, we see more ecological skincare brands that consider planetary health and protect local resources and biodiversity in their production processes (Campion, Barre and Gilbert, 2014). Arguably, a culture of caring for nonhumans and sustainable technological development can be better integrated, creating the potential for developing technologies and caring for nonhumans and humans. Ecological design may be framed and enacted to combine science and culture to create a path that will shape our acting, being and living sustainably (Orr, 2004).

Currently, most commercial companies tend to opt for technology-driven solutions to issues related to sustainability, including personal wellbeing and environmental problems. I note in Publication 3 that Shiseido has applied AI technology to skincare products and that the L'Oréal Group has used new technology to develop wearables to detect sun damage, recyclable packaging, and production process concerning biodiversity. Consumer goods companies such as L'Oréal hope to transform themselves into sustainable companies through technology. Compared with using digitalisation to promote sales, how to use technology to care for humans and the earth as both real and branding actions has become a key issue for sustainable transformations. This research connects culture and technology and examines future consumer goods from an ecological perspective[33].

The technological view here has two sides: first, culture affects technology, and second, technology is part of ecology. Technical practice is not neutral; it is influenced by cultural facts, including values, ethics, beliefs and creativity, by limiting the choices of many technologies and how to do technical practice and affect Life Styles (Feenberg, 2017; Pacey, 2001). Furthermore, cultural factors directly affecting technical practice can involve individual experience and tacit knowledge. The 'cosmotechnics' concept framed by Hui (2017) reveals that technical practice is based on different cultural and natural conditions and a way to unite natural order and moral order. Technical practice is a means for humans to participate in the ecological process.

The technological aspects in the Approach emphasise the importance of embodied knowledge connecting nature and culture, and technology is the material of design that can be used to

33 The emergence of different experimentally sustainable Life Styles opens potential spaces for design experiments. Shared living communities in the United States embrace low levels of technological and Indigenous knowledge (Schor and Thompson, 2014). The young generation has low desires for Life Style responses to economic and technology development in Japan (Atsushi, 2014). Shared bicycles, Airbnb, and shared economy are all sustainable Life Styles promoted in the media. However, the new environmental pressure caused by excessive shared bicycles and Covid-19 has brought challenges to shared living.

explore sustainable futures. However, the processes of technical practice are not neutral and are affected by both culture and nature. Therefore, we need a cultural perspective that highlights, problematises, situates and critiques a plurality of identities, values, ethics and beliefs when investigating future technological applications in design.

The three connected aspects can form the Eco-Cultural-Techno view to expand our visions of futures and rethink their role in design. Relational thinking is a key approach in this research to join different theories, explore futures through designing and further bring futures into the present as potential, possible and eventually actual anticipatory actions. There is thus a need to see how these various aspects of contextualisation may be differentiated and connected so that their relations can be more clearly patterned and put into motion.

4.3 The Eco-Cultural-Techno Design Speculative Approach

4.3.1 Outlining the Eco-Cultural-Techno Design Speculative Approach

Given relations of context, crisis and emergence, in this section I develop, propose and elaborate on a contextual, transdisciplinary and relational design approach to discuss the broader ecological tensions and needs of such crises and to provide alternative conceptualisations for framing sustainable futures. In this section, as a backdrop, I first present a number of additional key matters drawn from the literature and my inquiries into Life Styles and Life Forms and sustainable long-term futures. These key matters include the climate emergency and global crisis, ecology and sustainability, change and futures, techno-cultural settings and posthumanism and synergies. I then discuss these themes before moving to a subsection that covers the relations between them (nature, cultures, legacy, imaginaries, materials, artefacts, experiences, senses).

Finally, I draw these matters together in an analytical framing of an Eco-Cultural-Techno Design Speculative Approach in the context of climate change and long-term sustainability. In the following, I take up the first sub-question presented in Chapter 1, which concerns ways in which exploratory artefacts in research through speculative design may be configured in the present to help us shape and understand future visions and relationships between humans and nonhumans, society and the biosphere in support of long-term sustainability.

4.3.2 Summary of the Key Components

The proposed Eco-Cultural-Techno Design Speculative Approach (Figure 4.1) is a relational mapping and dynamic schematic concerning design, sustainability, climate change, futures, Life Styles and Life Forms. All the elements in the schematic are fluid and related and may move and be moved, with no necessarily preferred point, zone or band of entry. Equally, the

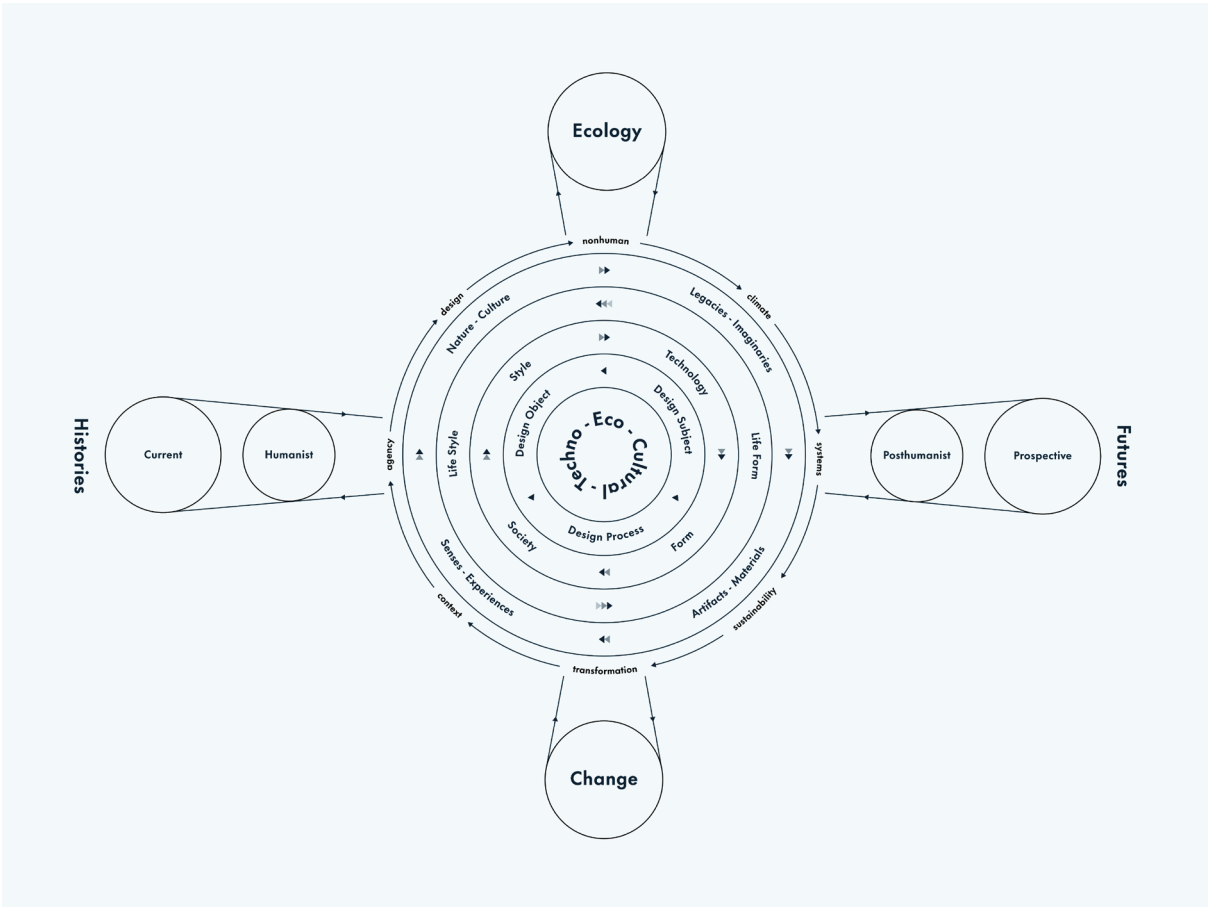
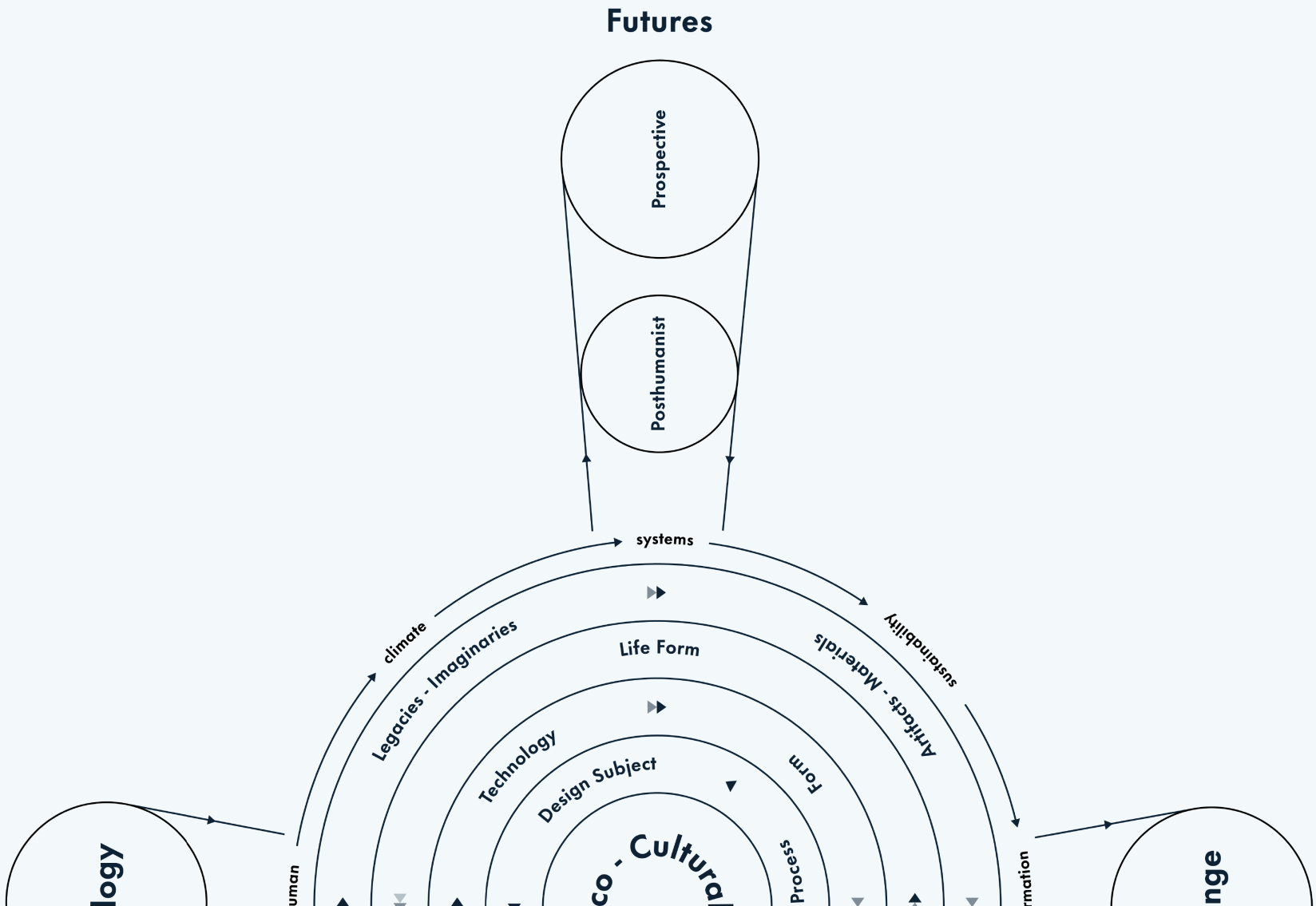


Figure 4.1 A schematic of the Eco-Cultural-Techno Design Speculative Approach for sustainable futures (Zou, 2022).

entire schematic may also be rotated when different bands generate motions and new relations. Further, as I detail below, the various layers may also generate diffractive meta-patterns.

Importantly, the entire schematic needs to be viewed as an interplay of the relations between history and futures in which current and prospective views need to be understood. This extends, as shown in the next chapter, to Life Forms and Life Styles. Further, historiographically, there is a shift over time from an analytical framing of these aspects from humanist ontologies to posthumanist ones. While time may appear to be linear in this schematic, it also moves from past to present, present to future and future back into the present. The ongoing dynamic of the Approach is addressed by the two key items of ecology and change, in which the main intention is to work towards more sustainable, equitable and survivable design practices and shared futures.

Histories
Current
Humanist
agency
design
Nature - Culture
Style
Design Object
Techno - E
Life Style
Society
Design
Senses - Experiences
context
nonh
transfo
Eco
Cha


Futures
Prospective
Posthumanist
systems
climate
Legacies - Imaginaries
Life Form
Artifacts - Materials
sustainability
Technology
Design Subject
Form
Process
Socio - Cultural
Human
Information
logy
nge

Categories

Horizontal and vertical sections:

Time: Histories-Futures
Stance: Current-Prospective
Ontology: Humanist-Posthumanist
Dynamics: Ecology-Change
Drivers: agency-design-nonhuman-climate-systems-sustainability-transformation-context

Central sections:

Lenses: Eco-Cultural-Techno
Scopes: Design Subject-Design Object-Design Process
Aspects: Style-Form-Society-Technology
Mediators: Life Form-Life Style
Elements: Nature-Culture-Legacies-Imaginaries-Materials-Artefacts-Experiences-Senses

The relations between the core elements and the wider context are realised through the activities and relations of design, agency, context, nonhuman, climate, systems, sustainability and transformation. In addition, at the edge of the inner core of the schematic and linked to centrally positioned features are a set of elements that are themselves in dynamic, nonbinary relations to one another: nature, cultures, legacy, imaginaries, materials, artefacts, experiences and senses. They are also realised through attention to design subjects, design objects and design processes and the wider contexts and aspects of change.

Immediately below, I summarise what is involved in the aspects of the schematic on the Eco-Cultural-Techno approach and the design subject, design object and design process and provide a brief orientation to the set of dynamic elements.

4.3.3 On the Layers and Dynamics of the Approach

The schematic includes a set of relational elements that are key to the elaboration of the top-level framing of the Eco-Cultural-Techno approach. They are included to address a wide range of elements that may be encompassed in a synergistic and relational ontology of working with speculative design and changing futures for a more sustainable world. The elements are not set up as binary oppositions; rather, the focus is on the relations between them, although they also shift and move to one another. This depends on what is being brought into focus by what acts of designing and analysing and in relation to whose intentions, interests and positionings.

In relational terms, it may be useful to clarify two slightly different positions from the literature. The first is a view that effects and influences are caused by relationships between humans and nonhumans (Latour, 2005). Second, an OOO view argues that nonhumans have their own effects, independent of human and human-nonhuman behaviours and consequences. In my view, I see relational ontologies as needing to span these two views.

Briefly, the nature-culture notion concerns wider aspects of nonbinary relations in a posthumanist ecological view. Legacy-imaginaries concern the dynamics between ways of conceptualising and actualising design in historical and futures views; design has always worked with imaginaries but now also includes critical views on growth. Material-artefacts naturally cover what materials are in play and how they are used in design that needs to work on scarcity, reuse and responsible making and caring for artefacts. Experiences-senses refers to the important aspects of embodied, situated and contextual feeling and being, including human and nonhuman actors and relations.

In a relational ontology, the elements are interwoven and dynamic in their states and processes. They are discussed in detail below, focusing first on wider human-nonhuman views and rebuilding and understanding subject-object processes as whole entities and the contexts, both historical and prospective, in the present. Second, different entities may have effects on the new relations between them. These relational elements are discussed in detail below after the wider aspects of the Eco-Cultural-Techno approach have been further elaborated.

Overall, the Approach may be seen as a means to provide a relational, contextual, positioned, analytical and transdisciplinary design-linked framing that supports inquiry into relations between design, sustainability, climate change, futures and Life Styles and Life Forms. The Approach has the potential to provide means and focus for ways to frame and conceptualise sustainable design research and – in the case of this thesis – to design Life Styles and Life Forms towards plural futures in a non-dualist, non-anthropocentric, transdisciplinary way.

4.4 Details of the Eco-Cultural-Techno Design Speculative Approach

4.4.1 On Design Subject, Design Object, Design Process

In long-term sustainable futures, the subject and object of the Approach might merge and be related to processes of design. The awareness of this merging has been embodied and embedded in non-anthropocentric design. Human-centred design sometimes makes us excessively consume natural resources and thus isolate ourselves from nature so that we cannot experience the effects of technology and our surroundings.

The object of design is not only human but also nonhuman. By developing consciousness of long-term sustainability, humans may come to realise that design might serve humans and the

nonhuman to contribute to ecological flourishing. Second, the subjects of design are diverse. Natural intelligences such as those found in plants can also help humans understand the world's mechanisms to protect them, as has been shown research into smart fungus systems (Tsing, 2015). Design artefacts can also be the subject in this view and process. As to technological development, we have discussed how AI as a form of super intelligence impacts us and our environment. AI may thus also become a subject to transform human conditions and culture through different interactions between humans and creatively designed AI. We can see these transformations in AI painting and digital agriculture. Third, the Approach enables linking these multiply designed subjects and objects to make new relationships as part of design and designing future processes. Sustainable futures may be discussed regarding how these subjects and objects collaborate to improve human wellbeing and ecological flourishing and contribute to their transformations.

As transdisciplinary research processes and methods, speculative design can create new ideas and connect knowledge in different fields through making and assembling (Wilkie, 2018). Speculative design research tackles a given topic and creates possibilities by making speculative artefacts. The ideation process connects different kinds of disciplinary knowledge as context studies in the ideation process. The making process brings embodied knowledge to design research, and design artefacts with different future scenarios as an assemblage of rich knowledge and ecology of speculative artefacts can be analysed from the view of an Eco-Cultural-Techno Design Speculative Approach. Speculative designing can connect different knowledge in different design processes. Design artefacts can also be analysed to see whether some aspects have been omitted or to rediscover certain problems and fields that were not initially involved. As an interdisciplinary method, speculative design research may provide an opportunity to explore or deal with complex issues, climate change, and the Anthropocene in an Eco-Cultural-Techno way.

4.4.2 Multiple Elements and Relations

In section 4.4.2, I listed and described eight dynamically related elements in the Eco-Cultural-Techno Design Speculative Approach: nature, cultures, legacy, imaginaries, materials, artefacts, experiences and senses. Next, I discuss these further under four main categories: field (nature, cultures), time (legacies, imaginaries), space (materials, artefacts) and affect (experiences, senses). I position the eight elements to discuss the larger relations – not the separations – between the ecological, the cultural and the technical.

4.4.2.1 Field: Nature and Culture

Our human engagement, behaviours and actions can happen in the mixed nature and culture field. Design is a way to organise different relationships between humans and nonhumans and limit and direct our living way by making artefacts in the field. Philosophers and feminists have proposed that culture and nature are not isolated and can be seen as a whole for

sustainable development (Haraway, 2003) and as biocultural creatures address biodiversity (Frost, 2016). The synthesis of nature and culture shows that their relationships are simultaneously driven by biophysical and social forces and can also be seen as a synthesis of humanity and technology.

We obtain different resources from the natural world to design products that enable more cultural activities that can change our conditions (Helmreich, 2015). Technology makes it possible for humans to obtain different resources from nature to create more designs that enhance human capabilities and make it easier for humans to transform nature – and to have destroyed it. In this situation, we are lucky to live in diverse cultures, but in the Anthropocene humans and nonhumans alike face the pressure of natural collapse caused by human choices and actions, including design.

The Approach allows us to see the various relational elements in respect to one another as a whole and to consider the ways that nature and culture interact with each other and evolve together. It also could be a way to help humans stay with relational connections in appreciating nature and culture in terms of the ecological crisis, with the possibility, for example, of working further with cultural scenarios to respond to that crisis and change what we do and how we think.

4.4.2.2 Time: Legacies, Imaginaries

Legacies and design histories do not limit creativity in design as imaginaries about and for futures. In the Approach, the legacy-imaginary relations are included to point to the ways that knowledge, experience and understanding are interlinked (e.g., Miller, Poli, and Rossel, 2018). The speculative futures perspective of the Approach includes intersections between the present and the past and informs our present and ways of long-term sustainability. A focus on the speculative future includes imagining those unthinkable futures that offer more possibilities than actual futures (Wood, 2016).

Looking at the past, designers can always find inspiration from stories, designs and Indigenous knowledge. In the XIANGVEI project, the sensory knowledge that may contribute to sustainable futures was discovered by tracking perfume's histories and related cultural and technical legacies. Leaning towards the future, uncertainty could provide designers with more design materials like emerging technologies and cultures (Malik, 2019). In the LO project, AI was used as a conceptual design material to explore different scenarios to shape new relationships of sustainable futures. Then, the inspiration of the Approach would become hybrid creative thinking that traces the past and speculates about the future.

In this hybrid creative thinking, designers may revive historically valuable concepts that are often forgotten in the face of the new technology that imbues modern culture. Designers and

designer-researchers may also embrace the future's vast uncertainty and create totally different concepts from the past. Design concerns the past and future, which have enriched designers' way of finding inspiration to respond to complicated ecological issues. Imaginative responses may reflect the future of culture, society and technology and provide potential solutions that bolster sustainability.

The designers' speculative futures would be their reflections of the present reality and design that may connect the past with the future. In this way, we might position DfS as a transition to a long-term sustainable society that is influenced both by the past and by imaginative speculative futures.

4.4.2.3 Space: Materials, Artefacts

In a relational view, physical and digital design materials and objects or artefacts can exist and be analysed at different scales, and design objects can be themselves or become new objects with others. All artefacts at different levels have unique effects and material compositions. A global view of the relations between material and artefacts is also crucial for the visions of long-term sustainability. Spatially, in terms of materials and artefacts, sustainable design has been discussing localisation and circular economy for some time (Wahl, 2016).

The climate crisis highlights the geographical and global impact of human-made systems on the environment within the broadest possible spaces, such as the academic education programme 'geo-design' at the Design Academy Eindhoven or SCI-Arc, which discusses local environmental issues from a global and geographical perspective. Long-term sustainable futures should be speculated and imagined beyond the current human perception system's scope, which is often based on new technologies to examine a specific local practice from a global and geographic perspective (Bratton, 2016a).

A global view could also provide the possibility of addressing problems caused by different geographies and cultures, such as the imbalance between the Global North and South (Fry, 2017). Working towards a more balanced global speculative future between the North and South could start, for example, from a small design product with extensive analysis of a global production system. Spatially, design as a cosmotechnics practice (Hui, 2020) involving human action in changing environmental and cultural and moral aspects might be locally situated within analysis linked with global geography, especially in a digital world where things can be connected easily and broadly. From this perspective, designing ecologically with materials and artefacts may be situated as and in local practice that is enhanced by a global and geographic perspective. The Approach may also be understood through different scales from the atomic to the cosmic to analyse the complex relationships of continual working for and attaining measures of sustainable futures.

4.4.2.4 Affect: Experiences, Senses

Attention to experience, senses, embodiment and affect are a key part of working with human engagement and responses to human-nonhuman relations (Jones, Mather and Uchill, 2016). In addition to sustainable and ecological design, future-oriented speculative design expands the role of design by working with socio-technical imaginaries and design fictions in a socio-political-cultural context. Speculative design uses design artefacts and is used in new contexts as a medium to discuss the potential and problems of relations between the sensory, embodied and experienced, directly and indirectly, in contexts of increased technological information in our society and our everyday lives (Auger, 2013; Dunne and Raby, 2013; Malpass, 2017).

Speculative design-related methods for futuring also offer us means to shape change and long-term sustainable survival. Amongst these in terms of engagement, design fiction can create a speculative persona and its contextual settings as the research object (Coulton et al., 2017; Morrison and Chisin, 2017), but also where we need to take the future back into the present –critically, emotionally and physically – as we re-engage in our own affective material and imaginary daily lives and societies.

Similarly, experimental futures work and research try to expand the future's ability as a medium where people can directly sense and feel futures through designed installations (Kuzmanovic and Gaffney, 2017). Experimental futures work and analyses connect considered investigations and embodied knowing in order to more fully understand futures. The anticipatory design approach introduces fact-based future speculations and situates studies in designing anticipatorially in a multi-perspective future-based inquiry method (Celi and Morrison, 2017).

4.4.2.5 Making Relational Connections

These relational elements and meta-categories have been presented to point to a range of core elements in working with matters of climate change and sustainability in a mode of research through speculative designing. These elements are interlinked in design works and processes that may help us to map, understand and analyse deeper posthumanist relations, as argued for example by Bogost (2012), and specifically for design (Forlano, 2017), between contexts and conditions and processes of working towards long-term sustainable futures. Together, these relational elements contribute to the connection of elements in context and thus also form a more composite if differentiated multiform context.

In terms of the ecological, I am interested in pluralities of the biological, environmental and climate systems. The ecological is also positioned within a posthumanist view that allows it to be seen as made of nonhuman and human activities and not as mere oppositions between them. To do so allows a fresh stance to be taken in working with my specific interest in Life Style and Life Form, where attention can be paid analytically to relations between the

ecological and the cultural.

Concerning the cultural, my argument is for critical attention to conceptualisations and practices of design in promoting endless growth-based consumption and ways to explore how to engage differently with cultural resources, artefacts and processes in framing more equitable and sustainable long-term futures. To do this, I create novel links between speculative design and posthumanist perspectives in patterning relations between humans and nonhumans in the Anthropocene and climate change contexts. I connect these links to critical technology theories oriented to experiences and expectations.

As to the technical, my work is novel in its connection between the ecological and culture and emphasises that practices and analyses relating to climate and sustainability are implicated in relations between the artificial of tools and technologies, such as sensors and satellite data and potentially AI systems. I adopt a critical view on the three main themes, and my Approach focuses on Life Styles and Life Forms as sites or venues for mapping out and further analysing their relations.

Overall, the Approach aims to create an atmosphere to engage with climate change and other ecological crises by making and understanding unique relationships towards our sustainable futures. The urgent need to avert climate disaster and shape long-term sustainable futures demands that design work critically reassess its foundations, motivations, practices and partnerships. When design faces the issue of climate change, how to create 'a new order' or new relationships to change the current, doomed trajectory of development is particularly important. This is, as Auger and Hanna (2019) argue, also political, and it is strategic; it demands changing design education and includes ways of working creatively and imaginatively.

4.5 Chapter Conclusion and Directions

In this chapter I have argued that there is indeed space to more fully and relationally unpack and position connect ecological, cultural and technological aspects and their intersections and overlaps. I also see that this is a matter of how multiple aspects may be patterned conceptually and spatially and appreciated as an additional transdisciplinary dimension; that is as Eco-Cultural-Techno poly-relations. This I have abstracted and explained in the form of an Eco-Cultural-Techno Design Speculative Approach.

In building this Approach, I have drawn on making practices of small, conceptual, and even playful and quirky heuristic designs to re-examine the existing relationships between humans, nonhumans and ecology and inspire some options to change existing relationships to respond to climate emergencies rather than functionally solve a specific ecological problem. My aim has been to stay with these many troubles by remaining within and working from a relational

ontological view that is nonbinary in toggling between imaginative making and critical analysis.

The Approach I have presented may offer us a means to change the existing research path, address the research role of designing and expand design research methods. This analytical approach may facilitate open-ended results with design and scenarios to present new relationships, integrating knowledge from different fields and disciplines and creating new opportunities for cooperation with other disciplines. The Approach allows us to relate to some degree to Life Styles and Life Forms as a research lens, which is covered in the next chapter. The Approach provides a frame from which to consider definitions of Life Style and Life Form from posthumanist and design perspectives. When Life Form and Life Style are interconnected, as I present next, the Approach may be used to analyse and discuss design through new Life Forms and relationships with new Life Styles. Then, we may bring the new opinions and inspirations of these designs back to reality to analyse how we can design and research critically in the present.

5. Developing a Speculative Life-Style-Form Design Perspective

5.1 Introduction

Drawing on the core elements and connections in the Eco-Cultural-Techno Design Speculative Approach, I have explored ways in which the abstraction of design, experience and analysis from my readings, speculative work, publications and analysis in the exegesis could be taken further to elaborate on the relations between the ecological, the cultural and the technical. I saw a need to pull together the work in my publications with recent developments in situating the complexities of climate change and sustainability issues. I explore the use of the conceptual understanding of Life Style and Life Form to further chart relations of elements in my Approach and views on Life Styles and Life Forms in producing and analysing the potentials and possibilities towards alternative sustainable futures.

After many rounds of reading, writing and drawing, I developed what I call a Speculative Life-Style-Form Design Perspective. At the beginning of my inquiries, this figural visual work mapped out and connected knowledge from contextual studies to support my design practice. I used it to explore possibilities and analyse my design work during the design process. The schematic coevolved with my design process; it has been a mode of thinking and knowing for me. The schematic itself illustrates that the elements may be understood and are placed in multiple, dynamic and even plastic relations to one another. The written text will necessarily present them in a linear mode of writing that should not be taken as a deductive mode of argument. This second schematic is a figural way to connect and relate different perspectives and concepts from contextual studies of Life Styles, Life Forms and posthumanism and to propose a speculative analytical design instrument concerning climate change and the Anthropocene with a focus on what I call Life-Style-Form. This Perspective is my analytical response to the second research sub-question presented in Chapter 1. It asks what qualities, characteristics and heuristics of Life Styles and Life Forms in the speculative design of hybrid artefacts – ecological, cultural and technical– may contribute to both human wellbeing and wider ecological flourishing in the context of sustainable futures.

5.2 Outline of the Speculative Life-Style-Form Design Perspective

5.2.1 Framing of the Speculative Life-Style-Form Design Perspective

This Perspective reframes the two key design elements of style and form, which have long been considered and discussed in the design field, from the consumerist world to the posthumanist

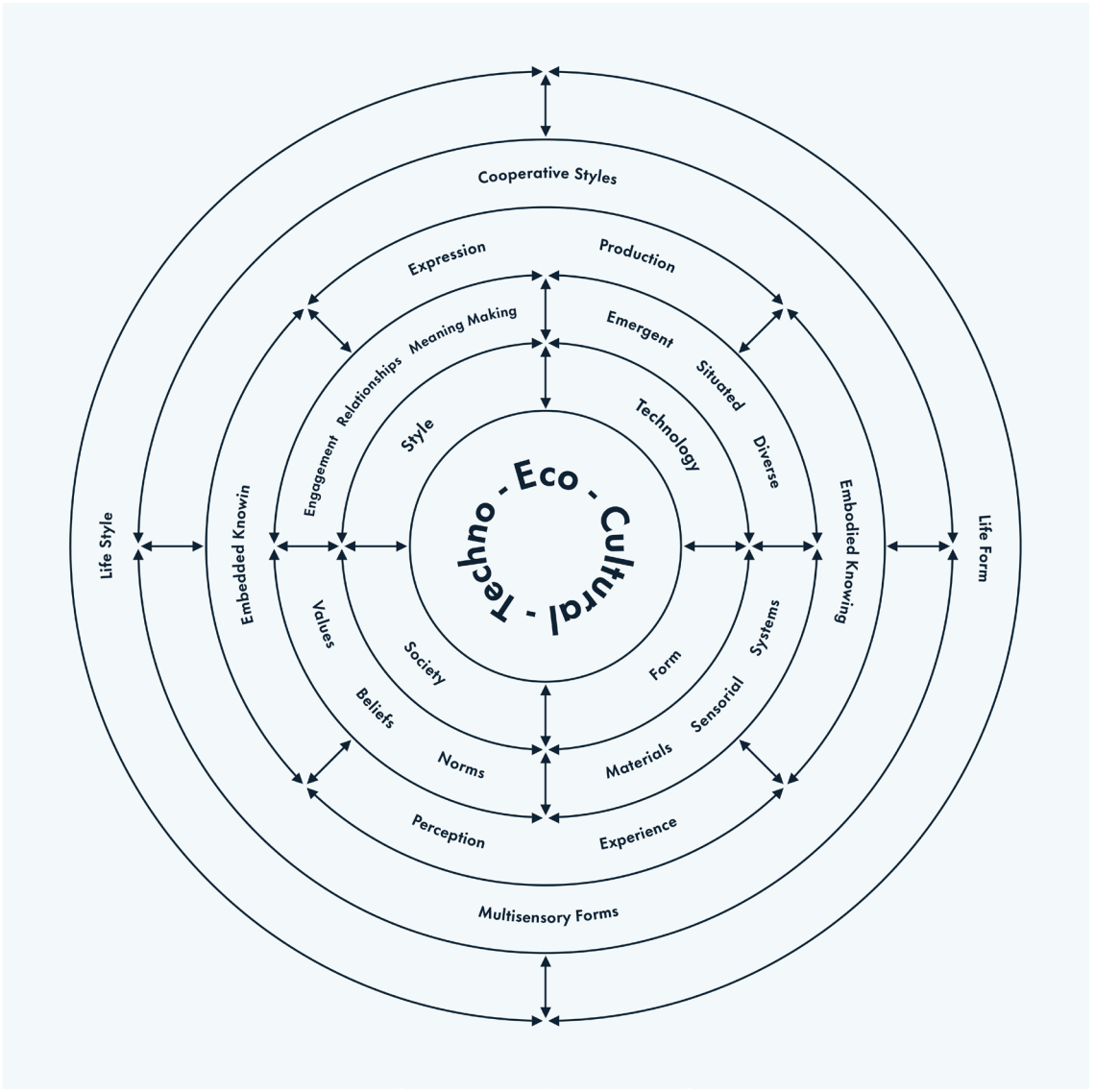


Figure 5.1 A conceptual schematic of the Speculative Life-Style-Form Design Perspective (Zou, 2022).

world. When associating these two elements with posthumanism, form and style may be understood as positioning life in a nonbinary world that is between the human and the nonhuman. The notion of Life Form includes diverse humans and nonhumans in the context of ecology. This serves to expand design researchers' and designers' objects so that humans are only part of the ecology (Morton, 2016, 2018). Life Styles may be characterised as the interactions and matter between different Life Forms. Futures design directed towards long-term sustainability may investigate changes in Life Forms and the interactions and matter between new Life Forms. A Speculative Life-Style-Form Design Perspective and its schematic (Figure 5.1) connect recent concepts and thoughts from posthumanism based on an ongoing development of a 'design language' to break through the existing dualist views in design (Forlano, 2017).

In addition to the details provided on posthumanist views (see Chapters 2 and 4), the Chinese thinking of yin and yang is an essential framework in my research. I use Life Style and Life Form to understand complex relationships and grasp different relationships' potentials and current situations. When Life Style and Life Form come together, they can make new relationships that can actualise potentials. The dualist way to arrange different elements and topics in my research is to find a way to connect rather than separate them. The purpose of the Perspective is to help designer-researchers and designers engaged in shaping and understanding relations and connections of future visions and relationships between humans and nonhumans, society and the biosphere to support long-term sustainability.

The Perspective can further clarify the Eco-Cultural-Techno Design Speculative Approach by drawing together relational elements from the Approach and exploring certain additional elements close to design. In this way, the Perspective generates forms of knowing and engaging through designing.

5.2.2 Key Elements of the Speculative Life-Style-Form Design Perspective

Next, I briefly go through all elements in the Perspective schematic from the innermost to the outermost ring. All the elements in the schematic can move, and each ring may spin or stop and expand or interact with other rings, thereby adjusting relations and presenting new or unseen ones. I present the elements in detail and build new definitions drawing on the research literature from posthumanist and design perspectives to indicate some of the potential relationships between them. The relationships still need to be developed and further analysed by design. This schematic is thus neither fixed nor universal.

I also introduce four main intersecting and connecting categories through which to present these elements: contextual aspects, types of knowing and engaging, types of Life-Style-Form and interrelations of Life-Style-Form.

5.2.2.1 Contextual Aspects

From the centre of the diagram and the Eco-Techno-Cultural label working outwards, the next ring (highlighted in Figure 5.2) involves contextual aspects, which form the largest number of items in the Perspective.

Figure 5.2 The contextual aspects ring in the conceptual schematic of the Speculative Life-Style-Form Design Perspective (Zou, 2022).

Style:

Scope: Multiple, varied, cultural symbols and expressions

Orientations: Engagement, Relationships and Meaning Making

Engagement: Individual, group and societal involvement, actions, behaviours and effects

Relationships: Concerning past, present and future, involving different participants and agencies

Meaning making: Interactions, dialogues, distributed, between partners and participants, and new relations.

Form:

Scope: Particular and hybrid shapes, materials, senses and systems

Orientations: Materials, Sensorial and Systems

Materials: Specifics and hybrids of physical, digital, bio and fictional materials

Sensorial: Attention to how senses, embodiment and feelings.

Systems: Institutional and infrastructural, configurations and organisation of material manifestations.

Society:

Scope: Dynamic, cognitive, tangible system, changes

Orientations: Values, Beliefs and Norms

Values: Sustainable living principles, aspirations and ethics, qualities of behaviour and dialogue

Beliefs: Acknowledgement of relations between humans and nonhumans

Norms: Critical views on norms, emergent guides and rules, dynamic generation via engagement.

Technology:

Scope: Emerging technologies, new scientific discoveries, inspiration, critical view

Orientations: Emergent, Situated, and Diverse

Emergent: Status, applicability and prospective potential of new tools and technologies

Situated: Criticality, contextual, popular cultural, applied and user oriented

Diverse: Local, Feminist, Indigenous and other perspectives and critical use practices.

Table 1: Contextual aspects.

5.2.2.2 Types of Knowing and Engaging

In this category, the next ring moves outwards. As highlighted in Figure 5.3, the elements span nature and culture and show how we are and live in the world through four types of knowing and engaging: perception and experience, production and expression, embodied knowing and embedded knowing. In brief, contextual aspects are defined with subcomponents elaborated above in Table 1.

Figure 5.3 Types of knowing and engaging ring in the conceptual schematic of the Speculative Life-Style-Form Design Perspective (Zou, 2022).

In brief, types of knowing and engaging are defined as shown in Table 2.

Perception & Experience: *Scope*: How we feel this world as input. *Orientations*: Perception, Experience Perception: addresses biological aspects Experience: addresses feelings influenced by culture.
Production & Expression: *Scope*: How we influence this world as output *Orientations*: Production, Expression Production: addresses the physical and biological influence Expression: address affective and cultural influence.
Embodied Knowing: *Scope*: Addresses nature, tactility, body, environment *Orientations*: Embodied Embodied: where knowledge is located in the body, environment, modes of becoming.
Embedded Knowing: *Scope*: Addresses culture, cognitive formations, systems *Orientations*: Embedded Embedded: where knowledge is located in mind, logics, institutions, policies.

Table 2: Types of knowing and engaging.

5.2.2.3 Types of Life-Style-Form

Next, I present the types of Life-Style-Form ring, as highlighted in Figure 5.4. Cooperative styles and multisensory forms are two examples of Types of Life-Style-Form; both were discovered in my doctoral research. In brief, types of Life-Style-Form are defined as shown in Table 3.

Figure 5.4 Types of Life-Style-Form ring in the conceptual schematic of the Speculative Life-Style-Form Design Perspective (Zou, 2022).

Multisensory Forms:
Scope: Life Forms, Sensory Futures, Embodied knowledge
Orientations: Sensory Enhancement, Multiple-species communication
Sensory Enhancement: Beyond mainstream sense types in consumerism culture
Multiple-species communication: New understandings between different Life Forms.

Cooperative Styles:
Scope: Life Styles, Equality Futures, Embedded knowledge
Orientations: Equality relationship, Sharing knowledge
Equality relationship: Wellbeing of whole ecological system
Sharing knowledge: Multiple Intelligence Cooperation.

Table 3: Types of Life-Style-Form.

5.2.2.4 Interrelations of Life-Style-Form

Taken together, these elements help generate, connect and differentiate a relational patterning of the key focus on Life Style and Life Form as labelled in the outer ring and highlighted in Figure 5.5. The interrelations of Life Style and Life Form are shown in a dynamic ring to generate the Eco-Cultural-Techno futures with other elements. As it is the largest ring, I try to argue in this layer that Life Style and Life Form cannot be separated; they are constantly merging, interacting, changing and influenced by design.

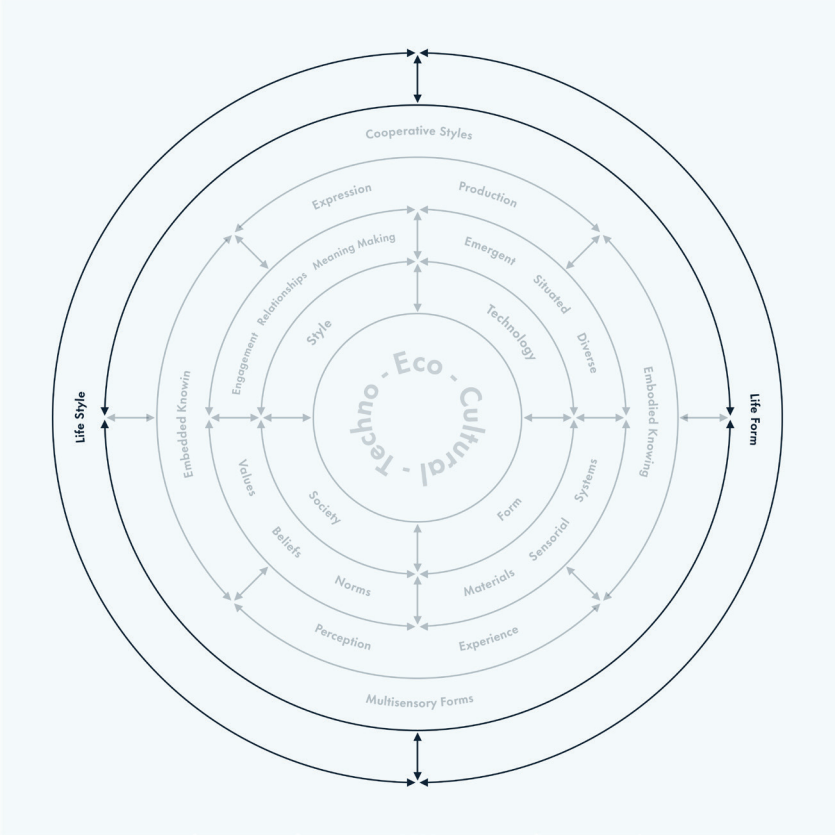


Figure 5.5 Interrelations of the Life-Style-Form ring in the conceptual schematic of the Speculative Life-Style-Form Design Perspective (Zou, 2022).

In brief, Life Style and Life Form are defined as shown in Table 4.

Life Style: *Scope*: Culture, Sustainability *Orientations*: Embedded knowledge, Affective forces Embedded knowledge: Emerging green or eco culture, care for nonhuman Affective forces: Behaviours or subculture, beliefs and norms.
Life Form: *Scope*: Nature, Sustainability *Orientations*: Embodied knowledge, Relational forces Embodied knowledge: Biological enhancement, technologies Relational forces: Multiple Intelligence cooperation, trans-relationship.

Table 4: Interrelations of Life-Style-Form.

Next, I elaborate on the main components listed above and relations within the Perspective by beginning this time at the inner ring to situate the Perspective with regard to Life Style and Life Form.

5.3 Elaboration of the Speculative Life-Style-Form Design Perspective

I now return to the centre of the diagram and the macro level of the argument. From it, I again work outwards to expand on content matters for each ring and the relations between elements in them. Later, I discuss more macro-level relations between the rings.

5.3.1 Contextual Aspects

The contextual aspects of style, form, society, technology are high-level components of the Perspective and broad abstractions that are populated with more specific elements. However, they contain a variety of views with and from which the Perspective may be understood relationally. Overall, this level of the Perspective is about connecting core intersecting categories with their contexts and aspects of what they may include.

5.3.1.1 Style

Style is not only about a particular expression of appearance as a cultural symbol[34]. It has multiple and varied meanings in terms of cultural and symbolic expressions. Spinosa, Flores

34 This definition of style can be tracked in the multiple meanings of Life Style from different disciplinary traditions and levels, which can be viewed as social values, self-identity and patterns of consumption to maintain the values and identities discussed in chapter 2.

and Dreyfus write that

> a style, or the coordination of actions, open a disclosive space and does so in a threefold manner: (1) by coordinating actions, (2) by determining how things and people matter, and (3) by being what is transferred from situation to situation. These three functions of style determine the way anything shows up and makes sense for us. (1999, p. 20)

Concerning engagement, I adopt a more general approach to ecological thinking in the Eco-Cultural-Techno context to explore style, including the engagements among nonhumans, including natural intelligence and artificial intelligence, new behaviours and actions and the effects of these new engagements. From a posthumanist viewpoint, style can be 'an assemblage emerging from the non-signifying collaborative practices of humans, objects and machines' (Hörl, 2013, p. 12). The relationships involved concern the past, present and future. Moving to meaning making, Style can be both negative and positive through discussing the meaning of caring relationships between humans and nonhumans in the context of climate change, beyond its decorative attributes of consumerism. When we look at style as a whole, we can use it to develop and exhibit behavioural interactions for values and identities, which are positive for sustainability, through feedback and artefacts and meaning making for belief in the caring process in which technology is also approached critically and in relation to diverse situations.

What is key here is how relationships and identities may be understood through the interactions between human and nonhuman participants and related systems, which may engage in dynamic expressions of the temporal that may take time to mature or become evident and in which we may enact relationships and make meaning. When focusing on style in this Perspective, what is most important is how it connects to the fundamental reconfiguring of relations of culture and nature and their interplay, as outlined in Chapter 4 in the discussion of the Eco-Cultural-Techno Design Speculative Approach.

5.3.1.2 Form

When discussing uncertain and potential futures, form[35] – seen as something beyond surfaces and shapes of artificial objects – is also not only about states but is also a way of being for anything comprised of different materials. This focus on the material includes biological, digital and fictional materials with 'aesthetic meaning' and 'morphological meaning materialized in physical potentials' (Helmreich and Roosth, 2016). Concerning the sensorial, aesthetics and morphological meaning as style are necessarily linked to how our senses and embodied experiences are engaged and how they generate wider emotional relations and feelings. With regard

35 Form is generally described as a particular way of existing with materials or the appearance of things to the senses. Aristotle contends that every physical object is a compound of matter and form. Pure forms mean natural compounds of materials that do not involve matter (Ainsworth, 2020). For architecture and design, form refers to the infrastructural configurations of material manifestations shaped by intended function, creative imagination, social and economic conditions and principles from particular designers, cultures and climates (Gelernter, 1995).

to systems, form may be appreciated at several intersecting levels: the micro, meso and macro levels of the institutional and the infrastructural, extending to how these aspects are configured and manifested organisationally in a systems view.

When considering how form operates in a speculative design for a sustainability frame, it may help us think of the materials used in and characteristics of design and how we may reconfigure materials to give life to more sustainable artefacts and processes. From this part of my Perspective, what is most important is how it connects to relations of senses and experiences and their interplay, as outlined in Chapter 4 in the discussion of the Eco-Cultural-Techno Design Speculative Approach.

5.3.1.3 Society

Society, viewed as societal design materials, focuses on changes in social values and beliefs and norms in histories. Human society can be understood as a coexisting system of cognitive and cultural beliefs, practices and performative systems. The cognitive system can be constructed by language, myths, social beliefs, social values and tangible systems built by everything that can be touched and seen, and these two systems interact with each other and direct societal development (Lent, 2017). Societal 'things'[36] as a real force for human development are discussed further in posthumanism and relational thinking theory.

In the context of my Perspective and sustainability, I position values as relating to propositions and ethical orientations and choices that both construct and facilitate behavioural qualities and dialogical practices. The existence of green social movements in now well established, even as other social values of sustainable living are disappearing, especially in the agricultural area. On beliefs, society can be viewed as changes in social beliefs and social values in the past and present to construct different cultures. Posthumanists in general locate belief in what they see as equal relationships between humans and nonhumans. This is shown in speculative installations that indicate that beliefs are dynamically generated but may also reproduce prevailing power relations and worldviews. Concerning norms and working for more equitable and sustainable futures, we therefore need to not only recirculate what is problematic but also to develop of norm-critical views and examinations of ways to stay with and learn from what contributes to emergent guides and their related 'rules'.

Speculative works, as propositions and instances of options and imaginary potentials, can embody and work to form new notions of problems and possible pathways as relations and ultimately actions. Sustainable cosmetics or clean beauty calls for cruelty-free and zero-waste exposure and proposes and perhaps reframes wider societal perceptions and alternatives,

36 For example, in OOO, Harman (2017) introduces social organisations or companies in history, even though they are disappearing now, as 'sensual' objects which could have a durable influence on our society.

practices and commitments. Here the focus on society also points to the notion of legacies and imaginaries outlined in Chapter 4 in discussion of the Eco-Cultural-Techno Design Speculative Approach, where working with past and future is situated via creative, heuristic works that embody and offer emergent relations between values, beliefs and norm generation.

5.3.1.4 Technology

In this Perspective, the inclusion of technology is important: technology can be understood to have been transformed by multiple forces – physical, ecological, cultural and social – according to Pacey (2001), Feenberg (2017), Hui (2017) and posthumanists like Haraway, Barad and Parikka. In this Perspective, I position technology as not only about craft and mechanical, industrial or digital and virtual developments, tools and means, also as needing to be connected to design and making, and there is a diversity of ways to make and view artefacts. On one hand, technology in this view could be influenced by style to produce both physical and social products in production and expression like clothing and fashion. On the other, from a posthumanist or non-anthropocentric perspective, technology is part of our ecology and is not limited to social and human zones.

Three topics are listed in the perspective: emergent, situated and diverse. Technology may be viewed as emergent, as when gene engineering changes our biological conditions and also changes our social conditions (Ginsberg et al., 2014). The emergent also includes attention to applicability and the prospective potential of new tools and technologies. However, these items also need to be viewed from a situated perspective and positioned critically in terms of their uses of materials and impacts on consumption and the environment. A contextualised view may also extend to what is a diverse take on technologies; that is, one in which worldviews and interests they represent and serve. This may be about local contexts of their development and use, change and effectiveness. It may include gendered and feminist views, for example, along with cultural worldviews, whether global or local, and inclusion and respect for Indigenous and historical notions and practices of tools, technologies and environments and related practices and legacies.

In speculative design inquiry, technologies may be put to use critically and by way of the future problematisation of artefacts, installations, narratives and other imaginaries to think about how we may select, position, connect and enact them within emergent, responsible and meaningful sustainable futures. This view of technology may be offered and critiqued to further conceptualise and realise an expansion of the spaces and meanings of technology in a wider view of ecology. This connects in particular to the attention given to artefacts and materials in the Eco-Cultural-Techno Design Speculative Approach.

5.3.1.5 Interrelations

These four contextual aspects work relationally to contribute connections between key

components and structures in developing the Perspective. They highlight views or aspects on sets of major influences and positionings. For example, style in different societies is a dynamic interplay of contextual moves and shifts, just as form may be altered by technologies in making processes and material investigations and uptakes. Style may also influence the uses of technologies and modify modes of production and expression. Society can also influence how we understand form experientially and perceptually. Within these contextual aspects I have also focussed on specific elements that need to be positioned contextually and in relation to one another. As a whole, the contextual aspects are therefore intersectional and dynamic rather than static categories. They may be linked back to the earlier framing of the Eco-Cultural-Techno Design Speculative Approach for long-term sustainable futures. These Contextual Aspects are further positioned with regard to what I term types of knowing and engaging. In the next subsection I go into these aspects.

5.3.2 Types of Knowing and Engaging

The Perspective includes types of knowing and engaging. This layer focuses on micro levels to analyse actions and behaviours and the interactions between them; they are not separate from one another but do need some elaboration.

5.3.2.1 Perception and Experience

Perception and experience refers to the ways we can understand the cognitive, affective and environmental aspects of how we encounter, experience and come to know and appreciate Eco-Cultural-Techno futures and how human-nonhuman relations are part of those futures. What is central is how human and nonhuman agents, participants and systems perceive and know the world; that is, at the level of input. At that level, perception refers to an understanding of biological attributes of sensing other things, and experience arises from the social attributes of sensing other things and is influenced by the social environment and moral and cultural values (Jones, Mather and Uchill, 2016). From a speculative viewpoint, technology may enhance biological abilities to improve or make a new perceptual system that can change our way of knowing and experiencing. New identities and cultural values could change how we experience and the kinds of technology that should be developed for enhancing the perceptual system.

5.3.2.2 Production and Expression

In production and expression, what is central is the output by participants to speculative experiments and engagements, whether human or nonhuman. Production may further provide physical or functional influence on other things. Expression can provide social influence through identity, moral orders and cultural values (Hui, 2017; Pacey, 2001). From an OOO perspective, production and expression holds that all objects (real and sensual) are equal (Harman, 2017). In this way, production and expression cannot be divided. They interact with each other to materialise affective and cultural influences and jointly produce embodied and

embodied knowledge (Frost, 2016).

5.3.2.3 Embodied Knowing & Embedded Knowing

These two types of knowing and engaging also particularly inform the experience and sense elements contributing to the Eco-Cultural-Techno Design Speculative Approach. However, that also needs to be positioned in what I regard as two connected aspects of knowing; namely, embodied and embedded (Law and Ruppert, 2016). They always appear together and are not dualistic; for example, in a nomadic version of the body where that body can be changed easily and can also change its mind (Braidotti, 2011). Embodied knowledge is located with the body of the participating human and nonhuman and subject-object-process, where relations to materiality and entity are connected to the environment and realised environmentally. In addition, this form of knowing is a matter of becoming from a process philosophy viewpoint (e.g., Fogelberg, 2021; Marenko, 2021). Embedded knowledge may be viewed as referring to knowing and processes that are located in the mind, logics and psychological processes but also connected to institutions and policies. Here, there may be a deeper systemic aspect to knowing that is connected to predominant positions and practices and their affordances and limits, which may need to be unpacked (van Helvert, 2016) in new modes of learning, design and change for more equitable sustainable futures.

Both kinds of knowledge are influenced and selected by society and technology. Embodied knowledge can be accumulated more readily with perception tool development, and different cultures can influence the understanding and experiences of the same materials (Ranisch and Sorgner, 2014b). Embedded knowledge can be accumulated more readily with technological tool development, and different cultures can influence its applications (Feenberg, 2017). Looking to the Eco-Cultural-Techno, this focus on types of knowing and engaging clearly connects to experiences and senses but more fully to modes of knowing and being. In the next section, I explain the relationships between the Perspective, Life Style, Life Form, speculative design and sustainability.

5.3.3 Types of Life-Style-Form

Two types of Life-Style-Form, multisensory forms and cooperative styles, were mentioned in Chapter 4. They are cases from my two speculative design research projects, XIANGVEI and LO. Publications 2 and 3 elaborate on what, why and how they are essential for sustainable Eco-Cultural-Techno futures. I briefly expand on them here and discuss their potential in Chapter 6.

5.3.3.1 Multisensory Forms

Multisensory forms are Life Forms equipped with design to enhance multiple sensory abilities and embodied knowledge to better understand others and environment. With the enhancement of the sensory, humans may better understand the environment to have opportunities

to care for nonhumans in the name of ecological harmony (Abram, 1997; Gagliano, Ryan and Vieira, 2017). Multiple senses can be developed fully beyond mainstream sense types in consumerist culture and expand our perception system to challenge anthropocentrism (Jones, Mather and Uchill, 2016; Morton, 2013). This may provide an alternative way of realising and experiencing embodiment and modality. With nonhumans and the environment, a generative culture of care may be conceptualised and contribute to the environment through multiple sensory understandings. Design may further contribute a value-sensitive design mode (Friedman et al., 2013) to care for multisensory forms. The point here is to address the sensibility of nonhumans and the environment beyond consumerist culture.

5.3.3.2 Cooperative Styles

Cooperative styles are equal, connected, multiple and sustainable components of Life Styles. To escape from the crisis caused by anthropocentrism, we need to nurture cooperative cultures among humans, earthlings and AI (Haraway, 2007, 2015; Tsing, 2015). Based on posthumanist cooperative culture, cooperative styles address the equity relationship between participants with the right to gain wellbeing for both humans and nonhumans. These extensive cooperative relationships can build reliance on the ecological system (Wahl, 2016). For cooperative styles, design may play a role in facilitating this relationship by changing actions, behaviours and interactions between humans and nonhumans and the values embedded in those interactions. For example, humans can learn from nonhumans and the environment and share their knowledge with them, which may build up new style relations between multiple intelligences (Fox, 2017) and Life Forms for ecological flourishing.

Multisensory forms and cooperative styles are interrelated and only have different focuses at the beginning; they finally come together as a whole as Life-Style-Form (see Publications 2 and 3). Multisensory forms may build cooperative relationships through new sensory understandings under a new Life Style. While cooperative styles raise the question of how we understand and care for others, that question addresses feelings and experience, which are related to our Life Form sensory system. Next, I elaborate further on the interrelations of Life-Style-Form through certain details of Life Style and Life Form from a design viewpoint.

5.3.4 Interrelations of Life-Style-Form

At this point, I argue that Life Style and Life Form are two important concepts for speculative design inquiry if we want to see alternative futures of everyday life outside the current and unsustainable model. These two concepts have many layers and connect different aspects that form a relational and nondualist Eco-Cultural-Techno perspective. Both can be analysed from a design perspective on everyday life. I now further explain the two concepts from a speculative design perspective.

5.3.4.1 Life Style

Life Style is conceptualised in posthumanism to show embedded knowledge to coordinate human actions and affective force from matters between humans and nonhumans. When exploring long-term sustainable Life Styles, design may look at emerging green or ecological behaviours or subcultures, beliefs and norms from a transformative perspective. These transitions are closely related to the changes of matters between humans and nonhumans. Designers reflect on these changes from historical and cultural perspectives to speculate about new human behaviour coordination through design, to the benefit of both nature and humans. The mutual evolution of style and society changes how we care about the nonhuman. These changes may influence social norms and structures and then influence embedded human knowledge formulation. Just like anthropocentrism, it runs through our society and culture. For example, humans may give robots their human-centred embedded knowledge and only design robots to perform services for humans. Altered, critical and exploratory design Life Styles could perhaps diminish and manage anthropocentric cultures and their embedded knowledge systems to create more sustainable and cooperative future cultures.

5.3.4.2 Life Form

Investigating the future of Life Forms as a design inquiry may help designers and designer-researchers imagine and understand future embodied knowledge and the relational forces contributing to long-term sustainability. When exploring new Life Forms, design may also be elaborated to explore two essential directions: life form enhancement and multiple intelligence cooperation. The cooperations may happen in transrelationships between human and nonhuman multispecies (Ávila, 2019) and AI (Haraway, 2003). Transhumanism has studied different technologies to enhance human beings and imagine their influences on human society (Manzocco, 2019), such as functional biological enhancement and wearable mechanical enhancement devices (Kelly, 2010). These designs may change our beings, and the Life Form of human beings is indeed undergoing dynamic changes. Design may enable the creation of different Life Forms like robots. The environmental crisis has also caused the disappearance of many Life Forms in nature, and scientists have researched new Life Forms in outer space (Helmreich, 2015). From the overall types, Life Forms have also undergone dynamic changes. By understanding wearable human enhancements, robot design and research on other natural intelligence, knowledge from these new Life Forms may increase our embodied knowledge based on the richness of the material world. Life Form poses questions for designers to consider ways to facilitate how humans and nonhumans may better live together and build a sustainable society partly through new human enhancement technologies.

5.3.4.3 Interrelations

I argue for the Life-Style-Form concept as a new understanding of Life Style and Life Form. This means that Life Style and Life Form are always interrelated and inseparable. They are linked by the four contextual aspects and formed dynamically and analysed by different

relational elements at different levels.

The Life-Style-Form concept is essential to the Perspective. According to Ehrenfeld's ecological thinking, the Perspective may also be seen as a scaffolding and articulation of the framing of long-term sustainability. Ehrenfeld and Hoffman (2013) advocate for two key points of ecological flourishing, being and caring, which correspond to Life Forms in nature and cultural Life Styles. Then, the Perspective on sustainability needs to consider Life Forms and Life Styles simultaneously. Life Form is about how to achieve sustainable being, and Life Style is about caring for others to build sustainable relationships. The Life-Style-Form concept leapfrogs separations of nature and culture and contributes to long-term sustainability by connecting the different elements in the schematic to combine different aspects and connect with the Eco-Cultural-Techno viewpoint.

5.4 Design and the Speculative Life-Style-Form Design Perspective

In this section, I suggest what might be implied when the Speculative Life-Style-Form Design Perspective provides a design framework for design inquiry to imagine, speculate and anticipate Eco-Cultural-Techno futures.

5.4.1 On 'Coevolution'

Referring to the Perspective, when style and form meet design under the umbrella of posthumanism, design may be read as a form of narrative about life with hope for sustainability. With a focus on technology, design could change Life Forms by enhancing some attributes of being or new artificial things as new Life Forms. With new values and beliefs of society, design could change Life Styles to create new relationships of care. Everything has a Life Form and Life Style, which may be changed technologically and culturally through design.

These new notions of Life Form and Life Style offer heuristics, sketches, prompts and options with which to engage the current realities of ecological crisis and technological development to open up new relationships through design between different things towards long-term sustainability. Life Style and Life Form may thus also be unified into the overall concept of Life-Form-Style through design.

In other words, design may connect nature and culture as rational and affective forces to promote human development through changing Life Styles and Life Forms, which interact with each other. This is a kind of coevolution of Life Style and Life Form through design for human development. The first coevolution occurs through experience. Our experience of different Life Forms, including human-made artefacts, is affected by society's value, structure and Life Style.

The enhancement of Life Form through design has changed our model of perception and our understanding of society and further influenced our Life Style. This is a kind of coevolution of Life Style and Life Form through design. The second coevolution is through production. Life Style may affect production since our production priorities differ with the importance of the things we care about. This could lead to different designed objects that use the same technology.

5.4.2 A Relational Prompt and Orientation

The Speculative Life-Style-Form Design Perspective schematic is a seemingly flat and flexible space to explore, understand and shape nondualist and sustainable future visions from an Eco-Cultural-Techno perspective through mapping, connecting and designing. Flatness means co-existing, and the subject, object and process of design will be more diverse. This schematic can be used as a perspective in design for humans, design for nonhumans and for design itself. The schematic is also oriented to the speculative, linking the past to the future to create a nonlinear viewpoint that can expand design materials and influence the present (see Chapters 6 and 7).

This Perspective might take a closer look at future possibilities through connecting and making rather than a classification of futures (as probable, plausible, possible or impossible) like the futures cone (Voros, 2015), which appears as a 'map' in some speculative design research. This schematic may be positioned in a future diagramming effort to form a complementary relationship with the futures cone and thus address alternative futures of sustainable development beyond the trends in our existing system.

Overall, the Perspective offers a relational prompt, orientation and guide of sorts in approaches to think with and identify different and novel relationships for further designing artefacts speculatively in the present. The schematic may provide space to line up different elements at different levels to form new relationships that may be thought with for design.

The elements with a multitemporal character may create plural views to challenge our current unsustainable situation. This may also help design researchers and those from different disciplines, perhaps including design students and teachers, to shape and understand future visions and relationships between humans and nonhumans, society and the biosphere.

Next, and in partial response to these claims, I refer to my design works and research to briefly explain how the Perspective may be applied and relate it to designing and how it may be further positioned from a design perspective.

5.4.3 The Speculative Life-Style-Form Design Perspective and My Design Inquiry

Two design studies articulated in practices through speculative designing as multiple and pluralist objects and installations have been central to my doctoral work: XIANGVEI and LO.

To recap, the first work XIANGVEI presents a designed organ of the human body. As a human organ, XIANGVEI is a human sensory enhancement that may be delocalised to produce perfume, redefine perfume's cultural activities and help humans have conversations with plants. This scenario reflects the way of being after the development of biotechnology and human caring for the nonhuman through cultural activities in which people cannot be isolated from nature.

In the second work, LO, I took up a designed robot as a cosmetic creature. LO was designed to create a new form of life that pays attention to human and nonhuman wellbeing through light-related knowledge to live together and make the overall ecology more prosperous. LO also reflects an extensive culture of cooperation between it and humans.

The Speculative Life-Style-Form Design Perspective and its schematic applied to these two design research projects offer two connected elements: 1) a conceptual, multi-level, relational space to analyse transdisciplinary knowledge, and 2) a speculative tool to design multiple and pluralist objects and installations by connecting or diffracting different knowledge.

The conceptual, multi-level, relational space has been used to locate the knowledge frames and elements and to inform designing and contribute to analysis. I further annotate part of the Perspective schematic, as shown in Figures 5.6 and 5.7, to elaborate on the qualities and components of XIANGVEI and LO, During my research process, I used the elements of style, society, form and technology to create various concepts to present sustainable futures by connecting these elements and analysing the concepts from different aspects: from engagement to meaning making, from material to systems, from values to norms and from emergent to diverse.

Next, I look at connecting knowledge and use. For example, in the XIANGVEI project (Figure 5.6), the concept of XIANGVEI connected the four contextual aspects to discuss Eco-Cultural-Techno futures. The idea started with assessing how to make an alternative scent practice within perfume culture. In the beginning, XIANGVEI connected do-it-yourself perfume from engagement, plastic surgery from technology, the bio-digital body human system from form and the equal relationships between humans and nonhumans from style. During the development of XIANGVEI, multiple prototypes connected all the elements in the diagram and added new features. Designing XIANGVEI was intended to understand the issues of alternative scent practices towards sustainability and to produce relational knowledge with the potential for

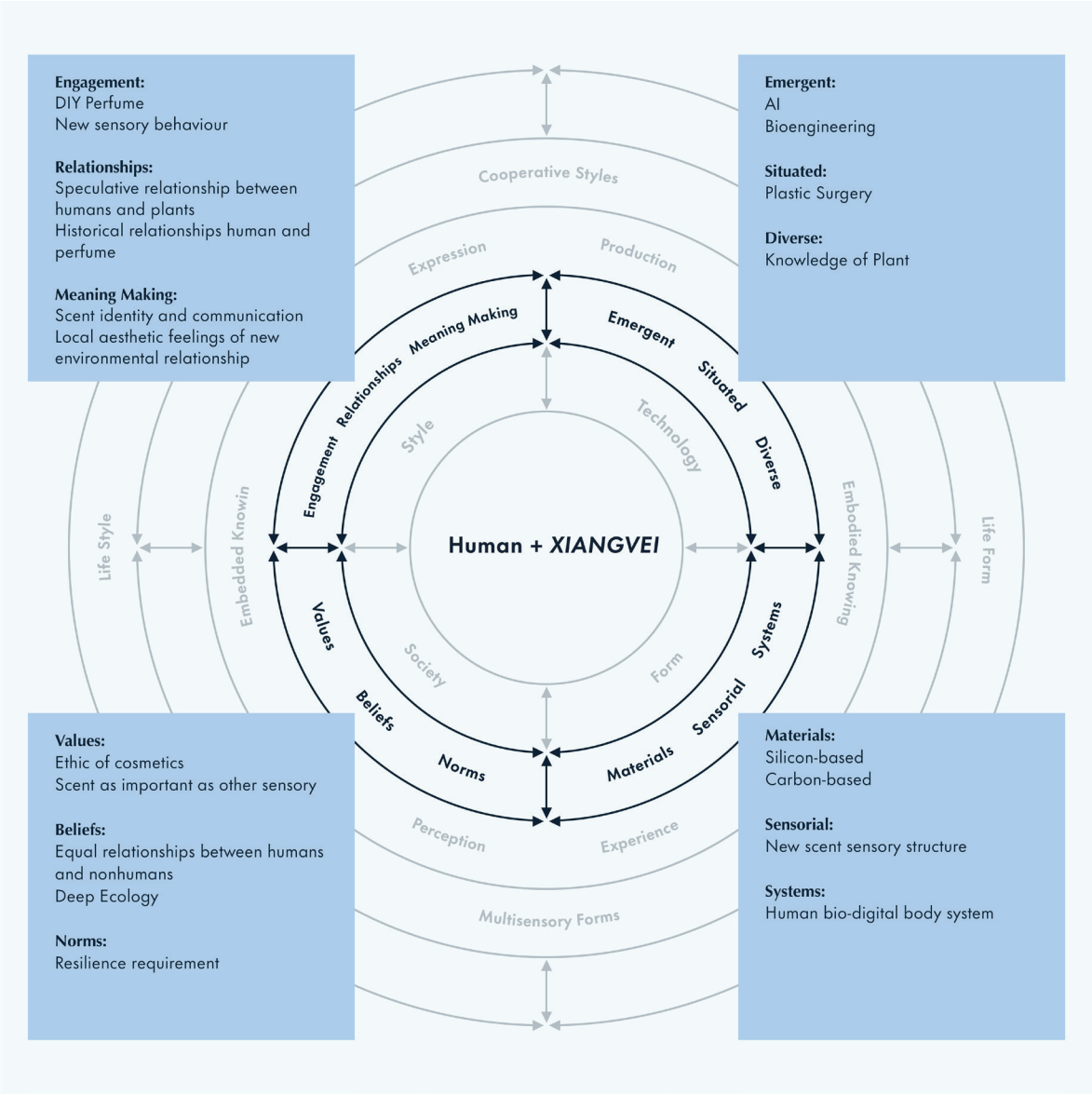


Figure 5.6 Mapping key elements of the XIANGVEI design study from the Speculative Life-Style-Form Design Perspective (Zou, 2020).

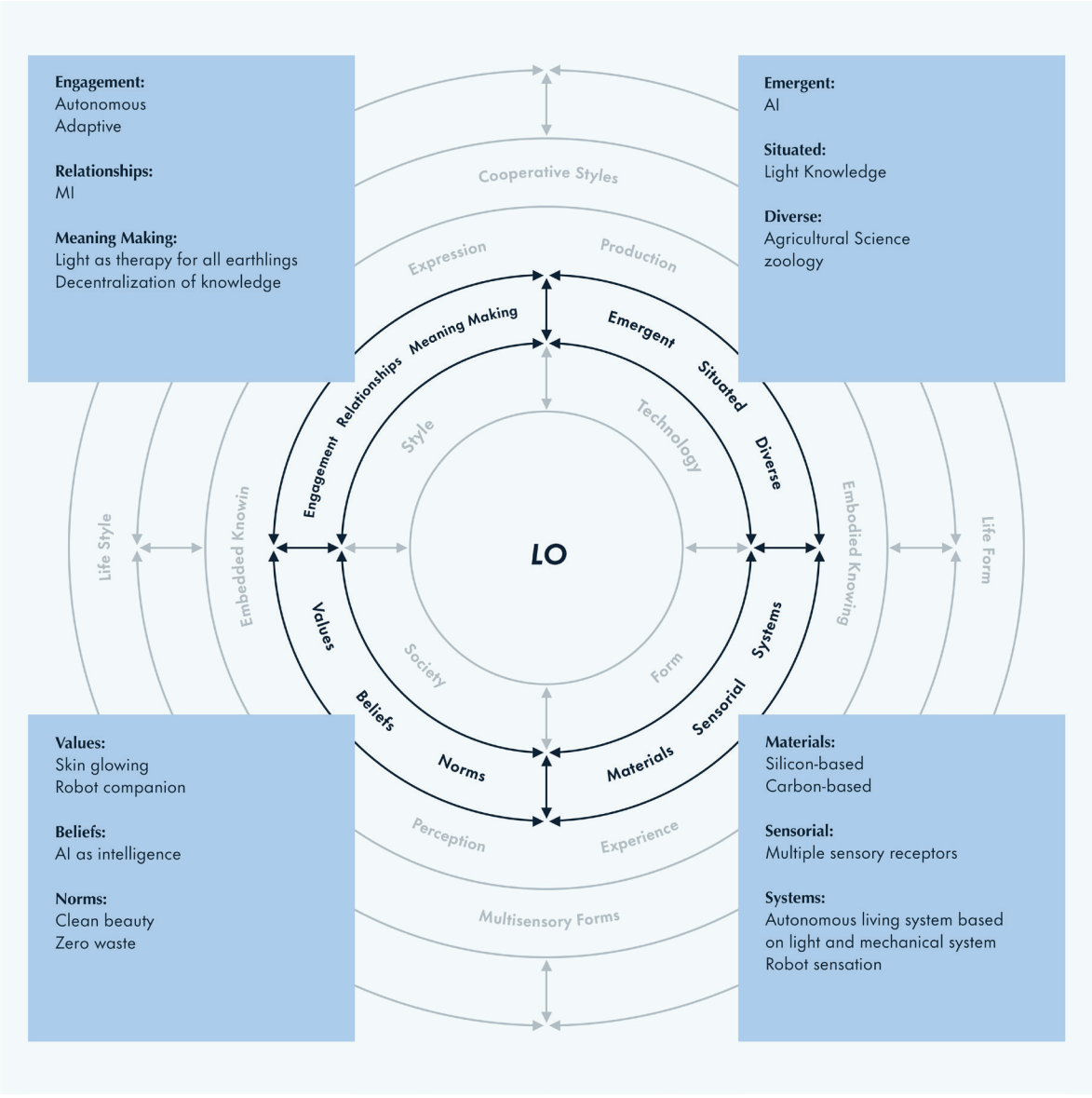


Figure 5.7 Mapping key elements of the LO design study in the Speculative Life-Style-Form Design Perspective (Zou, 2020).

relational implementations.

Moving on to analysing, the LO project (Figure 5.7) had the same process as the XIANGVEI project. I use the LO project to explain the Perspective further and to discuss its analytical role. The Perspective can analyse and connect different views on technology to create a view on how to think of technological developments. LO evolved with varying kinds of knowledge.

AI as an emergent technology can provide the LO with more autonomy to see the potential of AI sensation within cooperative cultures. Light knowledge as a situated technology in the LO projects was discussed in multiple applied scenarios. Light can be used in the cosmetics industry in a more sustainable way than chemical materials. Critically, we may ignore the rich meaning of the basic natural elements like light with an anthropocentric view. Light has many biological and cultural effects. LO also evolved plant knowledge as a diverse technology to discuss how we share knowledge with nonhumans and can further use Indigenous knowledge. Thus, the Perspective shows that the inquiries include growing and mixing further knowledge for designing. This Approach may offer designers ways to connect new knowledge to design subjects and objects by rethinking Life Styles and Life Forms.

For the Perspective, the design subject and object could be anything from cell to planetary system and from different times in the past and future; this reflects the notion of OOO that every object is equal and more than its pieces less than its effect (Harman, 2013). As a relational perspective, it could be used to analyse a single object or subject or multiple objects and subjects. For example, XIANGVEI and human are to be analysed as a whole, while LO is to be analysed as a single creature. Both designs are discussed within the popular and unsustainable cultural phenomenon of cosmetics to simultaneously address nature and culture.

The Perspective may help us design and analyse futures that cross the (ostensible) boundary between nature and culture by speculatively and creatively designing to connect the various elements in the contextual aspects category. It may also provide an analytical frame to discuss our futural beings and becoming towards long-term sustainability and explore how to achieve these beings and becomings by designing relationships between new reconfigurations of form and technology and assemblages of style and society. With this Perspective, my Eco-Cultural-Techno Design Speculative Approach may produce non-representational and intra-active knowledge of our sustainable futures through the posthumanist concept Life-Style-Form.

After two speculative design studies of cosmetics, I identified two sustainable future features (multisensory and cooperative) and discuss them further in Chapter 6. The process of following the two features through the schematic offers a way to discuss what kind of Eco-Cultural-Techno futures could contribute to long-term sustainability. Together, these two futures also show that style and form cannot be divided and may be understood more fully through the

relational concept of Life-Style-Form that I propose.

5.4.4 Some Reflections and Limitations

5.4.4.1 Reflections

> Biocultural creatures are anticipatory forms whose creative responses to the provocations of habitat draw on a rich and deep histories-of-responses. The different modes of responding over and through time not only make an organism a distinctive 'it' vis-à-vis its habitat. (Frost, 2016, p. 150)

As anticipatory creatures, we may see this Perspective as a speculative and anticipatory compass to connect different objects and subjects and form new relationships to coordinate human actions and change matters between humans and nonhumans. The concept of Life-Style-Form connects different theories that may help designers find a path for exploring futures beyond multiple dualisms like nature and culture, local and global and past and future.

Further, this Perspective may facilitate relational and transdisciplinary research that can embrace uncertainty and creativity. If the schematic can be seen as a cosmic vortex, all the elements may be the stars in the cosmos. The elements can move and be lined up randomly. When they are lined up and formed into dynamic constellations, we may find some constellations that may contribute to human wellbeing and ecological flourishing by analysing the constellations' composition and changes. Lining up elements at different levels may serve as a creative process to think with the Perspective and explore the alternative relationships between various theories, concepts and ideas.

This Perspective may provide different ways to think by using relational thinking on different topics and themes of design but focusing on Life Form and Life Style. Life-Style-Form may provide designers with two clues that address both the rational and affective forces for sustainable transformations when designing futures: the possibilities of changing the Life Form and the new values of these changes. The two clues together may facilitate the Eco-Cultural-Techno Design Speculative Approach. They may also help prevent designers from becoming lost in an enlarged Eco-Cultural-Techno space when facing significant climate change issues. Designers may then design to change the form of existing subjects and explore their new styles, or designers may make a new Life Form as a new subject through design to explore its styles. In this way, the Perspective may form a circle in perpetual motion to explore sustainable futures by building new styles addressing the social meaning and new forms addressing physical conditions.

Style and form are common design languages that may be easier to communicate and brand for the public and students. This Life-Style-Form could create a noticeable update of the classical notion of design in an ecological world. This means that I suggest building up some

design courses with the Life-Style-Form title to attract students and ask them to compare this Eco-Cultural-Techno approach with the human-centric design for commercial purposes that they have previously studied.

5.4.4.2 Limitations

This Perspective aimed to chart relations between ecology, culture and technology in the specific context of the two crucial interrelated categories of Life Style and Life Form. It was developed to find ways to generate an understanding that may inform the shaping of atmospheres for further action in design inquiry. I have presented some applications and the potential of the Perspective. However, I now present and discuss a number of reflections and limitations that I see arising from making and using the Perspective.

First, the relational charting is informed by a diversity of research and information that may be in need of further connection and distinction. A relational view does not seek some sort of universalist harmony, but such a perspective may need further clarification about strong, weak and transversal relations.

Second, it is not always easy to place concepts and hold boundaries fast within the rings; in designing, they are more fluid, as is the model in the more active applications. Therefore, a static diagram and linear presentation may limit thinking about and with the more dynamic relational qualities intended to be part of the Perspective.

Third, the playful and unfolding aspects of projects, in which participants and audiences may be more engaged than in my study, point to the need to look at the Perspective in more performative senses. Play, moving through boundaries and working against categories or rings may be just as valuable as mapping items to spaces.

Fourth, transrelations between the elements, which I overly broadly describe as all interrelated, may need to be more fully and dynamically explored and discussed, whether reflexively, diffractively or in terms of plural relations.

Fifth, while doctoral research is necessarily engaged with details and clarity is of course essential, the Perspective may be reconfigured to contain fewer layers or elements that could be shifted to contexts of application or use that could be situated in a given project or intention.

Sixth, a three-dimensional, dynamic model could allow for the identification of different elements, categories and relations though movement that the static diagram and written text simply cannot convey visually.

5.5 Chapter Conclusion and Directions

The Japanese novelist Haruki Murakami (2006) observes that 'when you come out of the storm, you won't be the same person who walked in. That's what this storm's all about'. We are in a storm. Our traditional dualist mind and anthropocentrism have caused this storm that may be seen as a 'hyperobject' that influences our lives in multiple ways and cannot be viewed from a single and simple perspective, following Morton (2013). Climate change, biodiversity loss and a global pandemic – and their relation to one another – are phenomena of the storm and not conducive to human survival.

The Approach suggested in and by the Speculative Life-Style-Form Design Perspective might guide us to try to escape the storm. We endlessly stimulate consumption for economic growth. We are living a life of excessive consumption, constantly and ruthlessly acquiring natural resources. The imbalance of economic growth also threatens human social life by broadening the gap between the rich and poor and increasing consumerism's damage to mental health. The ecology has multiple layers in the same way that Guattari (2000) proposed the concept of three ecologies (environmental, social and mental). The ecological crisis is not only environmental but also involve cultural issues of society and the individual.

We are indeed in this storm, and our wider ecology is gradually or radically deteriorating. We cannot see our current and future problems or their legacies because we are in the vortex of the storm. However, we might see ourselves after the storm as a kind of hope, which might guide us at this moment and let us make choices as to how to remain present and attuned to the issues and need to reach for and secure sustainable long-term futures. In this storm, design is also present as a special nonhuman that sometimes accelerates overconsumption. To explore the Perspective implies looking into a new design paradigm concerning sustainability that can transform current design assumptions, perspectives, practices and policies.

In Chapter 6, I discuss some potentials of the proposed Eco-Cultural-Techno Design Speculative Approach and its related Speculative Life-Style-Form Design Perspective that may be further developed and suggest how, in parallel to Donna Haraway's notion of staying with the trouble, we may stay with the challenges of working relationally with speculative design. I see this as needing humour and hope and engaging critically, sensorially, logically and emotionally. These matter together as we continue to encounter uncertainty and work creatively by designing in a mode of open and new relationships through both the Approach and Perspective.

6. Discussions

6.1 Introduction

My initial research question focussed on how to use speculative design inquiry to address long-term sustainability by investigating the future human quality of life in the context of climate change. In research through speculative design, I then developed an Eco-Cultural-Techno Design Speculative Approach through the new Life Style and Life Form concepts to elaborate on larger design ecologies. The global Covid-19 pandemic has magnified the necessity and importance of this Approach to the complexity of survivable futures.

One possible reason for the Covid-19 pandemic is that the colonisation of nature with new technological tools and economic needs has increased human contact with viruses in the natural world (Tollefson, 2020). Globalisation and the rapid development of transportation technology has enabled the rapid spread of viruses around the world (Saker et al., 2004). Robots are used in quarantine areas (Seidita et al., 2021), and drones remind people of social distancing (Vincent, 2020). Viruses as Life Forms can easily spread in human society, affecting our bodies and Life Styles. Masks affect how we breathe, experience our environment and socialise. All the design artefacts related to the pandemic have demonstrated coexistence and the cooperative relationship between humans, nonhumans and artefacts and revealed the complex of the Approach schematic (Figure 6.1).

In light of the pandemic, designing with the Eco-Culture-Techno view is no longer a tool to solve problems but a critical venue to establish new relationships by reconnecting elements of the Approach schematic with measurable effects towards sustainable futures. I explain these elements in the following sections by detailing the findings in the XIANGVEI and LO projects.

My Approach and the complex Eco-Cultural-Techno design ecology explores how design may facilitate new modes of being, living and growth to form new relationships with nonhumans and nature and create an awareness of quality lives based on different cultures and environmental conditions rather than a defined economic goal. As a relational response to the critique of sustainability, my Approach becomes about 'ings' (Lury, 2018, p. 2) towards a process to understand and build flourishing ecological relationships between humans and nonhumans through plural Life-Style-Form designs.

Plural speculative Life-Style-Form designs may provoke us to think of plural quality lives that challenge the current consumption model based on our experiences and senses and legacies

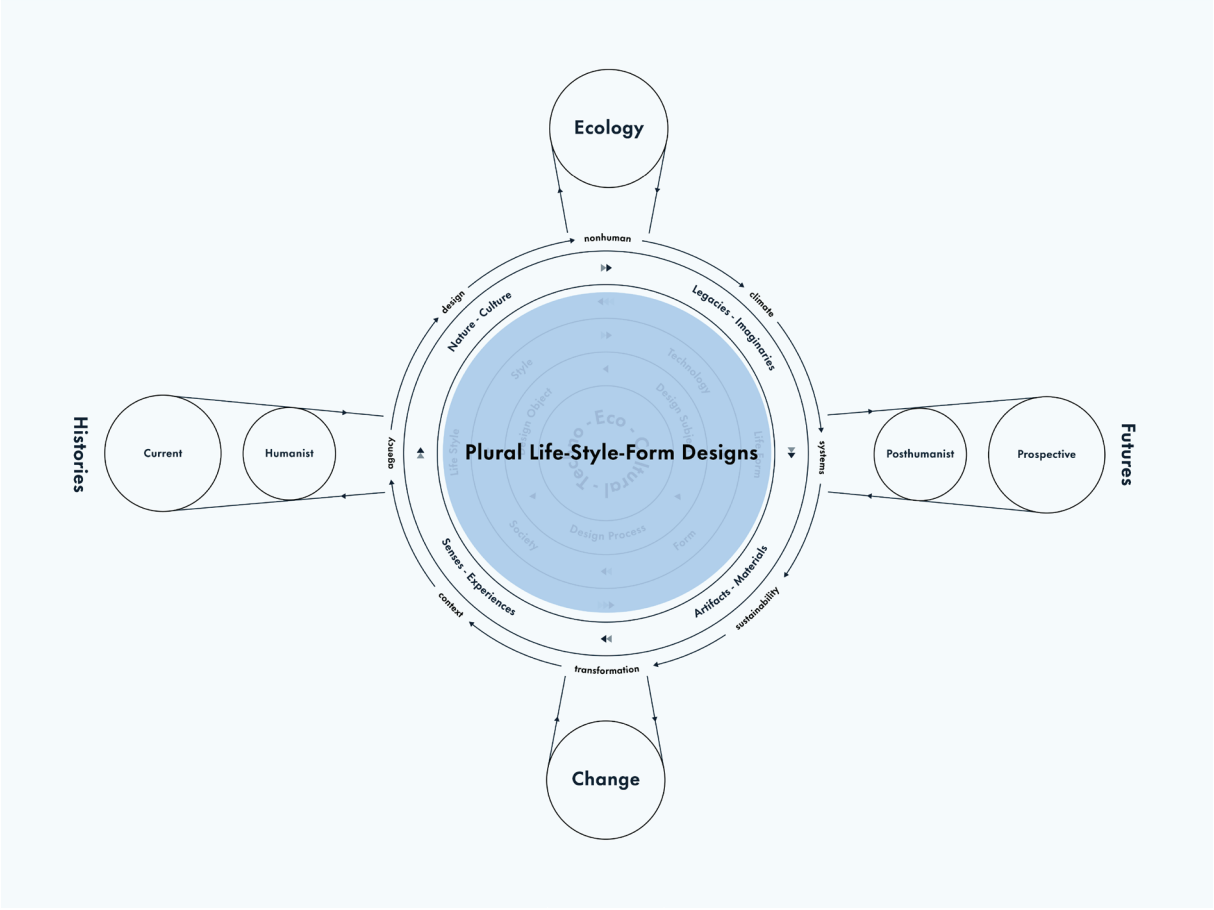


Figure 6.1 A schematic of the Eco-Cultural-Techno Design Speculative Approach (Zou, 2022).

and imaginaries, reflections on localisation through materials and artefacts, and further think of human development routines based on a new awareness of nature and culture. I think the necessity of this research may also entail exploring alternatives through speculative making beyond East and West to see our climate crisis from a larger perspective based on plural histories and futures.

Below, I discuss the futures of multisensory forms and cooperative styles I discovered in the XIANGVEI and LO projects and their applications to further describe my Approach and Perspective. Finally, I argue for a new kind of sustainable design towards long-term sustainability.

6.2 The XIANGVEI Project and Multisensory Design towards Sustainable Futures

In Publication 2, I explore the role of the multisensory in sustainability and design and their relationships to challenge the lack of sensory enhancement in our existing models of consumerism. Based on the XIANGVEI project and my Perspective, I elaborate further on the importance and potentials of designing multisensory futures for sustainability in my broader design ecology of the Approach (Figure 6.2).

First, multisensory design based on multisensory forms may be a potential way to understand Life Forms' enhancement of experiences and senses from a posthumanist viewpoint and think about the present potentials towards sustainability. Then, multisensory enhancement design towards Life Forms may support a localisation process of our everyday life, just as XIANGVEI used local materials to produce perfume artefacts. Multisensory enhancement design may also connect legacies and imaginaries to bring back cultural rituals that enhance our ability to care for the environment. Eventually, multisensory enhancement design could even change practical design from consumerism design to a new sensibility design by connecting nature and culture.

Below, I first review and discuss some cases of human enhancement to contrast with the sensory enhancement from the Speculative Life-Style-Form Design Perspective.

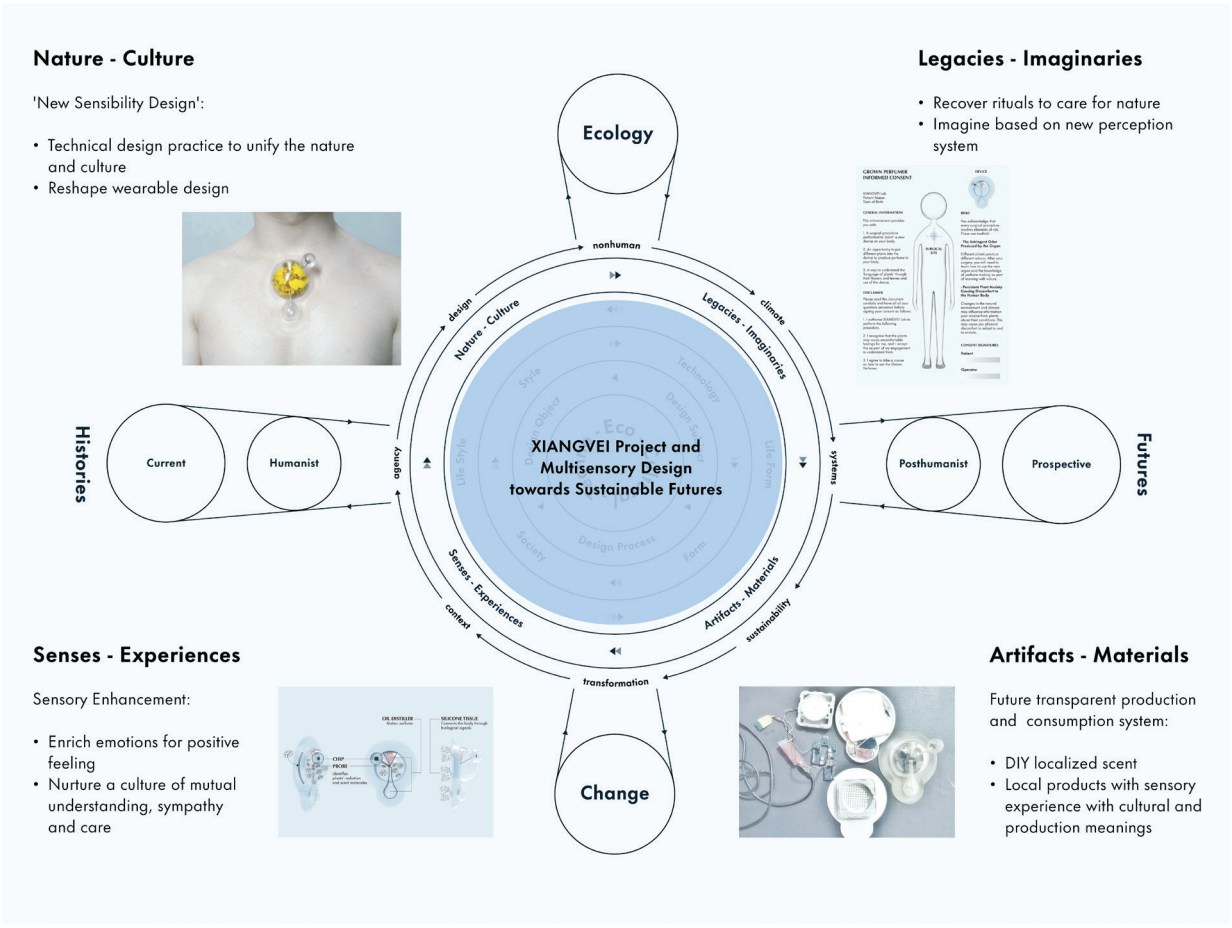


Figure 6.2 Mapping key findings of the XIANGVEI project through the Eco-Cultural-Techno Design Speculative Approach (Zou, 2022).

6.2.1 Reviewing Design Cases for Multisensory Forms

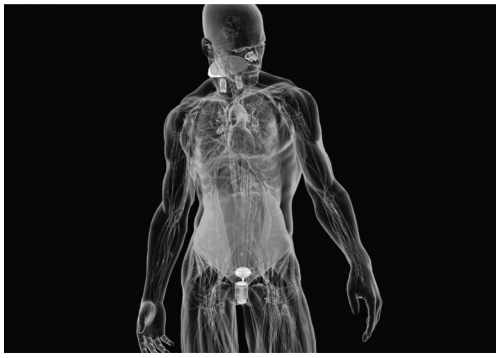


Figure 6.3 Takram, 2012, Shenu: Hydrolemic System[37].

Figure 6.4 Parson & Scharlesworth, 2019, Catalog for the Posthuman[38].

Figure 6.5 Kuangyi Ku, 2020, Perverted Norm, Normal Pervert[39].

37 Available at: https://www.takram.com/projects/shenu-hydrolemic-system.
38 Available at: https://www.parsonscharlesworth. com/catalog-for-the-post-hu-man-2019/.
39 Available at: https://www.kukuangyi.com/perverted-norm-normal-pervert.html.

In discussing methods, I noted that I conducted some case studies to define the scope of design research and design prototypes to better engage with other experts and the public. I found design cases related to human enhancement, organ design and the posthuman through exhibitions, books, and the Internet. I listed three cases that did not appear in Publication 2 to show how the XIANGVEI project was defined at the beginning : 1) Takram studio (Figure 6.3) has explored a new body organ to save water, respond to future water crises and address the new functionality of Life Forms; 2) Parson & Charlesworth studio (Figure 6.4) has developed a series of human cognition enhancement products to discuss products' social influences; and 3) Kuangyi Ku (Figure 6.5) was inspired by snails' sexual behaviours and created speculative designs of human sex organs to discuss gender politics. These design projects are all related to changing human Life Forms to address different ecological or social abilities.

All three cases discuss posthuman possibilities through human enhancement and their impacts on society. The changes we make to our bodies affect our perception and experience and production and expression. These cases are all well-explored elements of the schematic, which reflect the strengths of the Life-Style-Form concept as a whole to discuss our Eco-Cultural-Techno futures from a joint cultural and ecological perspective. This inspiration from the schematic allows me to discuss scent as part of the body enhancement in the cosmetics field to discuss the attributes of sustainable futures from a posthumanist view. Thus, I chose to explore human sensory enhancement for long-term sustainability from the Perspective with the schematic. I now discuss some matters of sensory futures that look towards long-term sustainability.

6.2.2 Senses-Experiences: Changing Life Form Towards Long-term Sustainability through Multiple Sensory Enhancement

The XIANGVEI and LO projects both explore the role of senses and experiences in the context of climate change. XIANGVEI is more focussed on changing Life Forms through sensory enhancement, while LO deals with the relationships between Life Forms through senses and experiences. Future human enhancement towards wellbeing and long-term sustainability could mainly work on sensory enhancement, which is absent from modern consumerist culture. Human beings have always sought to make themselves more robust and healthier. However, the goal of human enhancement in a consumerist culture also accelerates the consumption of natural resources and causes waste. Genetic and mechanical engineering provide the possibility for these enhancements, but excessive enhancements have caused damage to our ecosystem. Humans often neglect sensory enhancement, which can enrich our emotions for positive feeling (Desmet and Pohlmeyer, 2013) and allow us to understand the environment more fully. Many sensory augmentations, like virtual reality and augmented reality, are already being used in our daily lives to enhance our perception system (Bratton, 2017), but there is little research exploring the role of multisensory futures for sustainability.

Transformations of the human biological condition by design and products as extensions of the human body may be seen as opportunities that may be explored through Life Forms and Life Styles lenses rather than threats to ecological futures. XIANGVEI as a sensory enhancement of Life Forms may provide an unexpected and transformative media to change human bodies and reconnect humans with the environment, the planet and ecology. Sensory enhancement may be viewed as a way to create a new sensibility between humans and the environment. Humans do not need to follow the notions of solutionism and transhumanism to infinitely expand their biological capabilities, achieve immortality or become semi-robots to consume more natural resources. In my view, the loss of sensory experience in the contemporary world has contributed to a culture of reductionism that dominates the mainstream world, as I argue in the three publications. However, as a sustainable alternative to the continued consumption and eventual exhaustion of resources, we may need to nurture a culture of mutual understanding, sympathy and care through rich sensory experience and knowledge instead of a higher, faster, better culture based on values that are now indisputably self-consuming and self-destructive. Design could enhance the human sensory system to form a culture that cares about the environment for long-term sustainability.

6.2.3 Artefacts-Materials: Localising Sustainable Life Styles through Multiple Sensory Enhancement

XIANGVEI as an artefact also reflects the fact that sensory enhancement may increase the value of localisation, which has long been an important part of sustainable practices because it forms small circular systems that lead to a more resilient larger system. XIANGVEI is a generator of perfume, and the human body becomes perfume generators. It gives humans the autonomy and fun of production and reflects localisation's unique value because of plant materials growing in different geographical environments.

The value of localisation may be increased by sensory enhancement concerning production, consumption, expression and experience. From a poetic or romantic perspective, we ignore multisensory feelings in production processes; nor do we assign this feeling and sensory knowledge to the products and their consumption with cultural values and identities, separating human beings from the natural environment (Jones, Mather and Uchill, 2016). We have lost the sensibility to perceive these local products' cultural and sensory meanings during the production and consumption processes. The reconstruction of sensory design could help form the value of localisation in all aspects of life – ecology, culture and technology – which could involve coevolution (Hui, 2020).

During the cooperative-making process in Shenzhen, I felt the pressure of the intense competition that comes with the globalised production system. Many manufacturers care deeply about the potential for future mass production with high quality control demands to ensure that their products or product components can enter the global market. However, quality control

and standardised mass production often ignore the better experience that comes from difference. Standardised production requires consistency in products, even the smell of skincare products containing natural ingredients. The smell of natural ingredients will change based on their growing conditions, and customers often use scent to check whether skincare products are fake. This leads to producers interfering with natural variations. Instead, we may choose to create a culture that respects the diversity and dynamics of scent, encompassing information about the environment and the production process by enriching our sensory ability and embracing localisation.

Although the XIANGVEI prototype was eventually made of silicone in Shenzhen, a world centre of electronics production, it mimics a human organ to provide an atypical experience that challenges the current system of commodities and indicates a transformation of ecological production. First, as biotechnology develops in the future, more biomaterial products that meet the sustainability challenge will be produced. For this reason, some schools have opened bio-related design programs to train future sustainable product designers. Second, consumer products will no longer only be manufactured using standardised production systems. From the user perspective, products need to be individually customised; from the producing side, biomaterials need to be considered with more emphasis on localisation. Lastly, bioproducts will require the careful consideration of ethics in the future. This places a demand for transparency in regard to future production and distribution. As the XIANGVEI project demonstrates, we need to be aware of the damage to individuals and the environment caused by bioproducts and their production systems. Being a part of the human body, XIANGVEI must meet the requirement of long-term use and expand the human ability to self-sustain a localised quality of life.

6.2.4 Legacies-Imaginaries: Sustainable Life Style of Caring Environment through Multiple Sensory Enhancement

Sensory enhancement could not only allow humans to understand futures with legacies but also to build a new sensibility between humans and the nonhuman to increase the understanding between them and further help each other through imaginaries. In human history, there are many rituals of building cooperative relationships between humans and nonhumans (Abram, 1997). These rituals also help humans go beyond the small human-made space that separates human beings from nature. Our current technological applications have isolated human beings from natural environments and replaced them with the digital world, which means human beings do not receive feedback from their surroundings and the consequences of technology like the climate crisis. Some researchers have used data visualisations of climate change to warn the public, but these projects evoke short-term feelings and do not help people truly feel the crisis in their daily lives. With the appropriate developments, human technology could enable humans to better understand nonhumans through sensory enhancements in the future. For example, the XIANGVEI project could lead to a kind of perfume for humans

and also make humans understand plants' conditions through the radiation of plants and further understand the language of plants (Gagliano, Ryan and Vieira, 2017). This could be the first step for transforming how we experience nonhumans through cultural activities towards sustainable futures.

Cosmotechnics is a theoretical concept that could link human-made digital systems with the natural world through cultural-technical design. Human beings cannot live within human-made worlds and enjoy sustainable futures by communicating only with virtual humans generated from human data (Andrea, 2019). The cosmotechnic idea of XIANGVEI is to connect more human systems with nature through smell so that humans may understand their surroundings, achieve a new sensitivity and enhance their abilities. These abilities could help humans exceed the current perception system (Jones, Mather and Uchill, 2016; Morton, 2013) of anthropocentrism for long-term sustainability.

6.2.5 Nature-Culture: 'New Sensibility Design'

Value-sensitive design (Friedman et al., 2013) as a sustainable design approach focuses on promoting human wellbeing. The Eco-Cultural-Techno Design Speculative Approach tries to position sensitivity in posthuman cooperative culture to enhance a value-sensitive design caring for both humans and nonhumans and connecting nature and culture. In that cooperative culture, we may form a new consumption model of the kind demonstrated in the XIANGVEI project focussed on the sensory and sensitivity so as to build up a sensibility for understanding between human and nonhuman rather than concentrating on the human experience. The related practice of what I call new sensibility design may not be a luxurious experience of services but a rich (positive and negative) experience of a new sensitivity for mutual understanding, sympathy, love and a foundation for generating a culture of flourishing (Ehrenfeld and Hoffman, 2013). Through new sensibility design, humans may understand their rich environments rather than isolate themselves in human-made environments geared to satisfying human desires at the cost of a habitable planet and its ecological survival.

Furthermore, since cultural models and personal experience can influence technological development (Feenberg, 2011; Pacey, 2001), new sensibility design may address the importance of the sensory, which may be viewed as embodied knowledge for directing technological development towards sustainability. Sensibility here means having plural ways to sense one's own body, other humans, nonhumans and the environment with an eye to mutual understanding, sympathy and care.

These new thoughts of sensory design would profoundly reshape the design of everyday products and current Life Styles in the same way that wearable products, such as mobile phones and digital glasses, did in the last decade or two. However, current design methods are still human-centred, which continues to isolate humans from nature. The new concept of sensory

design could enable wearables to link humans and nature and thus assist in better local practices. At present, there are e-noses and better hearing devices. Combining these technologies with design products may allow humans to better experience their surroundings and to take care of nonhumans and their environments.

In summary, new sensibility design may be put to the creative and critical work of culture to allow humans to have more profound and situated sensory experiences that enable understanding the environment, which may bring rich environmental factors into human-made systems. In this way, Life-Style-Form design artefacts may challenge overconsumption practices that operate without awareness of ecological crisis and facilitate consumption activities with a cooperative culture through multisensory technical enactments.

Suppose embodied and embedded knowledge could work critically together through AI and sensory design for cultural activities. In that case, wearable devices could become a cultural device like XIANGVEI to facilitate a new sensibility and allow culture to flourish for a highly adaptable society (Ito, 2017). This kind of device enhances not only our human abilities but is also an intelligent argumentation. Scientists argue that the best scenario is the cooperation of intelligent argumentation and AI (Case, 2018). The next section discusses another potential in my research, cooperative styles, through which AI and intelligent argumentation may better support long-term sustainable futures.

6.3 The LO Project and Multiple-Intelligence Cooperative Design towards Sustainable Futures

In Publication 3, I argue that cooperative futures as a key characteristic of posthuman futures working towards sustainability and design may facilitate cooperative relationships between multiple humans and nonhumans. Below, I further discuss the importance and potentials of designing cooperative futures for sustainability through the Approach (Figure 6.6). These design potentials may involve enhancing embodied and embedded knowledge, sharing human knowledge with nonhumans and building cooperation with multiple intelligences. Finally, taking up these potentials, I foresee the need for a non-anthropocentric multiple-intelligence cooperative design for long-term sustainability.

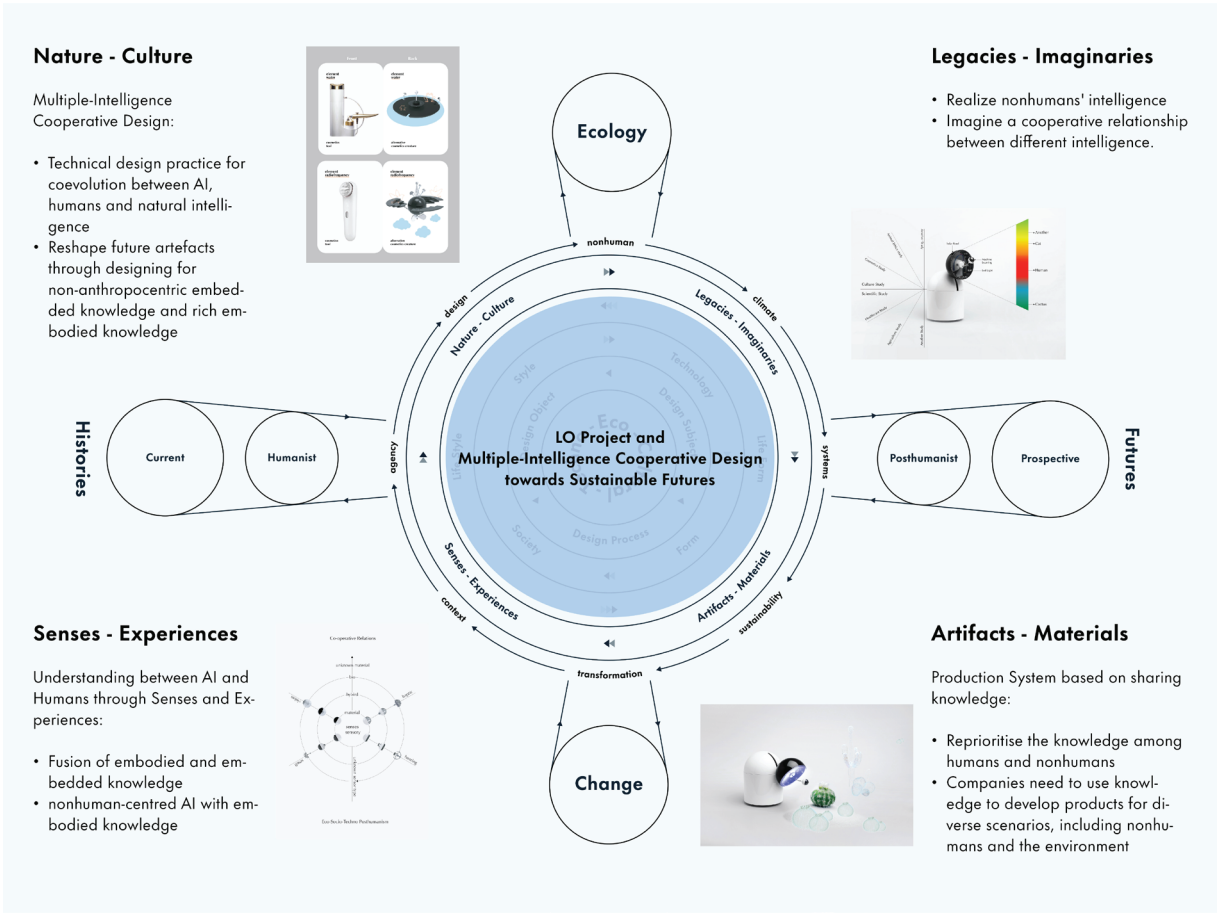


Figure 6.6 Mapping key findings of the LO project through the Eco-Cultural-Techno Design Speculative Approach (Zou, 2022).

6.3.1 Reviewing Design Cases for Cooperative Styles

Next, I review three design cases from others to show plural forms of cooperative design relationships from speculative to practical and rethink plural cooperative relationships from my Perspective.

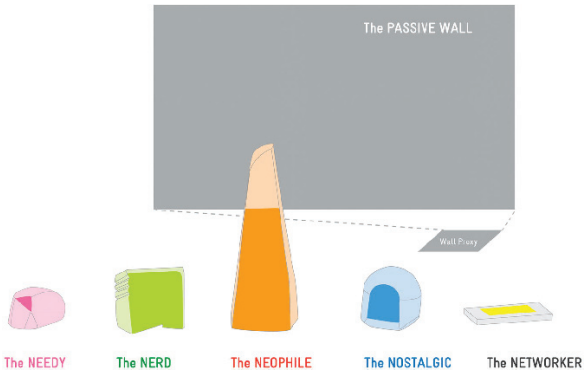


Figure 6.7 AniThings project schematic. (Marenko and van Allen, 2016, p. 60).

1) Betti Marenko and Philip van Allen advocate animistic design (Figure 6.7) in which digital creatures could have autonomy and awareness in uncertain, unpredictable and nonlinear ways from a posthumanist, non-anthropocentric point of view. They design a 'heterogeneous ecology' through independent and autonomous devices with their own goals and intentions that interact and respond to one another and to people (Marenko and van Allen, 2016, p. 59). Their design suggests that we could understand ourselves through the uncertain relationships between humans and artefacts. Moreover, these uncertain relationships between humans and nonhumans may provide an opportunity to understand the environment in diverse ways beyond our human world.

Figure 6.8 Stephan Bogner, Philipp Schmitt and Jonas Voigt, 2016, Raising Robotic Natives[40].

40 Available at: https://philippschmitt.com/archive/2018/work/robotic-natives.html.

2) The Raising Robotic Natives project (Figure 6.8) develops a speculative robot to replace humans feeding babies. This design raises some questions about the cooperative relationships between robots and humans, one of which is whether a cooperative relationship could be formed if children have a parental-like closeness to the robot from birth. Another question is whether a new culture might emerge in which our whole society can realise that robots are friends, not enemies, when the children grow up.

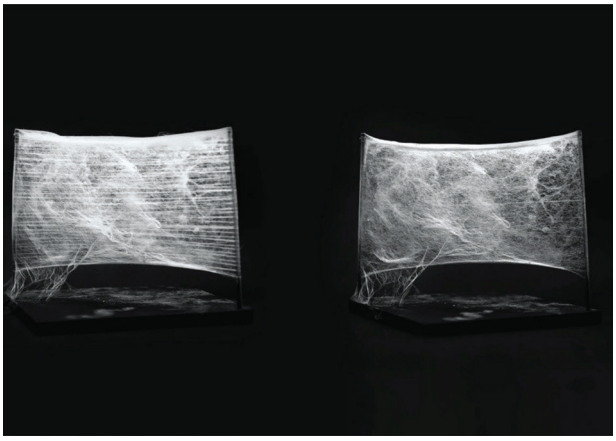


Figure 6.9 Neri Oxman, 2013, Silk Pavilion[41].

3) Neri (Figure 6.9) explores how humans could cooperate with natural intelligence like silkworms to make architectural structures through digital fabrication. Neri and her team spent 10 days cooperating with silkworms and a loom-like robot to create a structure comprised of silk strands that, combined, were longer than the circumference of the Earth by using a kinetic mandrel designed to guide the natural spinning motion of the silkworms. Designers may make artificial digital and biological creatures in the future, leading to cooperative relationships between humans, AI and natural intelligence.

These projects demonstrate the possibilities of collaboration between multiple intelligences (Fox, 2017). Cooperative relationships in these projects happen between different intelligences in different ways, but always with a culture where cooperative relationships are the root of being, living and developing. A characteristic of today's AI is that it is made by humans for humans. Relationships between humans and AI and humans and natural intelligence are not cooperative; indeed, they are computationally functionalist. From my Perspective, the question here about cooperative style is really about how different Life Forms cooperate and how to nourish a cooperative culture.

41 Available at: https://oxman.com/proj-ects/silk-pavilion-ii.

6.3.2 Senses-Experiences: Life Form towards Sustainability through Enhancing Embodied-Embedded Knowledge

The speculative LO's sensory system leads us to think of how different Life Forms sense and experience one another. We enhance our intelligence and create AI that ranges from digital AI systems to physical robots. These artefacts are often based on anthropocentrism and used to sense and experience the world. Humans want to create robots to serve humans that are entirely consistent with themselves. These robots also have a human way of thinking, are isolated from the natural world and have lost their uniqueness to become extraordinary intelligences in cooperating with humans. Some studies about robot sensation have proven that achieving super AI requires sensory knowledge of the environment and not simply embedded human knowledge. The fusion of embodied and embedded knowledge allows these super intelligences to achieve their particularity (Coleman, 2019; Howard et al., 2019; Lee, 2020) and contribute to multiple intelligences' cooperation towards sustainability.

Regarding sustainable futures, embodied knowledge connects robots to a wide range of ecosystems, and this knowledge can also balance embedded knowledge from humans into a nonhuman-centred position. This kind of nonhuman-centred AI with embodied knowledge could have a broad sense of cooperation with humans and will not produce a robot culture that conflicts with humans. Embodied and embedded knowledge working together can strengthen the cooperative culture for humans and the nonhuman, including AI, and eliminate the conflicts with nature caused by anthropocentrism.

6.3.3 Artefacts-Materials: Sustainable Cooperative Life Style through Sharing Human Knowledge

As AI, LO could share the knowledge humans have learned from the nonhuman when humans have developed products for themselves with nature. In this way, human beings learn from nature and feed human knowledge back to nature in a form of reverse biomimicry. Humans have accumulated knowledge in agriculture, zoology and genetic engineering that can serve the natural world. While humans treat the knowledge that serves them as high level, the classification of this knowledge is anthropocentric and lacks awareness that humans can cooperate with nature through this knowledge.

Designed intelligence like LO allow humans to see the richness of knowledge and how they can give knowledge back to nature. Thus, design could be a means of giving back to nature, and design would not only be for people. When designing as a process in which knowledge circulates between human society and nature, design could serve as a process of cooperation between humans and nature and become a cooperative culture that cares about ecology and changes matters between humans and the nonhuman.

Different fields of knowledge concerning light can be used to develop LO. The question I posed at the end of my third publication was who will emerge to make designs similar to LO: Cosmetics firms, agricultural concerns and robotics companies are all possibilities. When I was working on the LO demo prototype in Shenzhen, the manufacturer suggested developing some subsequent evolutionary robots based on LO for the Chinese market, such as intelligent lighting that could interconnect with human emotions. In the Chinese market, customers like to buy products with smart characteristics. This suggestion shows that identical human artefacts in different contexts will have different cultural and biological effects. The point of opportunity in the future is to put existing designs into different scenarios that allow them to take on new roles rather than always using scarce resources to develop novel products. For example, cosmetics companies might develop a system of light for taking care of our skin and then convert that technology into products that can repair our earth. Therefore, future production systems should be based on sharing knowledge, which will broaden and deepen the scenarios in which a product can be used for sustainability. The necessary sustainable transformation should focus on the entire distribution of knowledge through design materialisation and the practice of artefact design.

6.3.4 Legacies-Imaginaries: Sustainable Cooperative Life Style through Multiple Intelligence Cooperation

Humans and AI have intelligence, and the nonhuman in nature, like animals and plants, has intelligence as well. We have already seen nonhuman intelligence, such as the fact cacti can live in the desert and that dogs can smell Covid-19. LO, as a manifestation of AI, shares and contributes to the knowledge of light among humans and nonhumans to make connections between the three intelligences. These are all our legacies to better understand our surroundings and gain more knowledge from them.

In light of the current ecological relationship, which is full of unevenness, these three intelligences should be better coordinated through some posthumanist imaginaries to repair this relationship and achieve ecological resilience based on the most extensive cooperation (Wahl, 2016). This flourishing ecological culture is realised through the cooperation of multiple intelligences (McCue and Holmes, 2018). Humans should respect natural intelligence, like the smart cooperation between mushrooms (Mancuso and Di Stefano, 2018) and the contributions of birds to human cities, from a posthumanist perspective. These natural intelligences are already smart enough, as can often be seen in Indigenous knowledge. Humans could respect and cooperate with both natural intelligence and AI through design that contributes to ecological flourishing.

6.3.5 Nature-Culture: Multiple-Intelligence Cooperative Design

In the future, a move to greater equality for design could see the plural meaning of things and design for ecology (Cohen and Duckert, 2015), not only humans. Equality in design could be

more about treating all elements of the world as equal and designing based on a culture of cooperation and respecting nature. In this way, design could benefit more from posthumanism and relational thinking. Then, design would not pay too much attention to the nonhuman as totally equal or blindly worship self-evolution through technology (Negarestani, 2018). Equality in design could form a posthuman-centric design towards Eco-Cultural-Techno sustainable futures.

With the development of AI technologies, we have to consider co-performances between humans and nonhumans in design practices to integrate human and artificial abilities (Giaccardi and Redström, 2020). LO tries to explore a kind of non-anthropocentric intelligence design to address further cooperative relationships between humans and nonhumans and the effects and matters of the relationships in the Eco-Cultural-Techno system. LO as a form of intelligence design may demonstrate the potential for coevolution between AI, humans and natural intelligence and advance nature and culture in sustainable futures beyond developing problem-solving robots or specific AI. This means that future artefacts with non-anthropocentric embedded knowledge or logic and rich embodied knowledge may have unique positions, sensation and cultures as specially designed subjects in our society (Coleman, 2019; Leach, 2020). As Haraway writes,

> eschewing futurism, staying with the trouble is both more serious and more lively. Staying with the trouble requires making oddkin; that is, we require each other in unexpected collaborations and combinations, in hot compost piles. (2016, p. 4)

We cannot yet fully know how to deal with conscious AI in the future; conscious AI has been described as a catastrophe that may wipe out humanity (Armstrong, 2014). We may speculate on what kinds of information or futures we want AI to know and learn to avoid such a catastrophe. The goal of these futures may be to help AI develop a non-AI-centric view to live with humans, and the futures should be based on a nonhuman-centric viewpoint.

The futures may require changing the dominant anthropocentric thought of humans, making design too human-centric and commercial to maintain capitalism. Instead of colonising and controlling robots, intelligence designers with a non-anthropocentric perspective may leap outside the category of humanoid robots to design human-friendly intelligence that may connect to local environments, ecology and planetary. From a posthumanist view, non-anthropocentric intelligence design may be viewed as a cosmotechnics practice (Hui, 2017; Pavanini, 2020) participating in the ecological system through cooperative design artefacts.

These 'odd' designed intelligences may serve the fuller ecosystem and not only humans – or only rich humans – as part of that ecosystem. Based on plural, local, cultural and environmental conditions, this designed intelligence may make a diverse and reliant world with humans carrying out redirected and sustainable practices. Then, multiple-intelligence cooperative

design in the context of climate change may still be human-centred but in the specific sense of cooperative relationships with nonhumans and environments.

The futures of both sensory forms and cooperative styles provide some inspiration for future sustainable design research and practice as to ways, scope and type. Next, I show three new features of the Eco-Cultural-Techno Speculative Design Approach with its perspective, which may be used to work towards sustainable futures.

6.4 The Eco-Cultural-Techno Speculative Design Approach as Futures of Sustainable Design

Design changes our being and caring and has become the key to ecological flourishing, as I have illustrated through the Approach and Perspective focus on Life Style and Life Form. Sustainable development requirements have affected different disciplines, but design is the most comprehensive discipline to support sustainable transformation through a broad view revealed in the Approach and Perspective. Below, I position the Approach and Perspective in regard to matters of sustainability and relations and connections to design towards sustainable changes. I do this by referring to design approaches that focus on futures, media and cooperation.

6.4.1 A Long-Term Sustainable Futures Design Approach

My Approach and Perspective provide some scaffolding for discussing multiple roles of the futures in long-term sustainability. The Approach and Perspective schematics themselves reflect a highly speculative production process in imagining these futures. As a relational frame, the Approach and Perspective schematics may help us rethink what sustainable design is and how we carry it out.

I reviewed the development of sustainable design in Chapter 2, from green design to transition design (Ceschin and Gaziulusoy, 2016) and multiple concepts of design related to futures. First, my Approach and Perspective extend the scope of sustainable design from changing social-technical systems towards futures (Irwin, 2015) to imagining Eco-Cultural-Techno relationships embracing uncertainties to understand current troubles and anticipate plural futures emerging from those relationships by analytical frames. Although my Approach begins with humans, it emphasises creating an atmosphere of respect and co-design with nonhumans (Smitheram and Joseph, 2020) by designing artefacts from the Eco-Cultural-Techno perspective. Once such an atmosphere is achieved, we can establish more practical design actions to create a co-living world of humans and nonhumans that flourishes and trigger transformations (Jullien, 2004). Then, we can contribute to nonhuman-centric sustainable design, starting with ourselves.

Second, my Approach may extend Montgomery's concept of futures design (Figure 2.4), which is the overlap of design, futures studies, strategy and speculative design, anticipation studies (Celi and Morrison, 2017), art, science and engineering. In addition, it may address transdisciplinary collaborative making (Wilkie, 2018) and the media design view (Morrison and Chisin, 2017; Morrison, Tronstad and Martinussen, 2013) for analysing plural Eco-Cultural-Techno futures. The frame of the Approach and Perspective hope to obtain insights from the futures to alter our current values, belief system and paradigm, all of which threaten long-term sustainability. The complexity and flexibility of the Approach and Perspective connect the humanities and the sciences, making the design itself a hybrid of mediation and knowledge, attitude and social reality, nature and culture.

Third, my Approach bridges the gap between sustainable and speculative designs. Complex future scenarios can provide a nonhuman-centred perspective on sustainable futures, such as a world in which LO lives and humans have XIANGVEI organs. Importantly, every nonhuman is intelligent, but sustainable design needs to begin with humans and make humans respect nonhumans to create cohabitation with other intelligent creatures. We cannot design for nonhumans from our superiority, so the future of sustainable design still favours changing our relationship with the world to maintain our species. Therefore, sustainable design for nonhumans must begin with humans and the future.

6.4.2 A Long-Term Sustainable Media Design Approach

The Approach and Perspective may be viewed as a hybrid of mediation and knowledge that could support sustainable transformation through design and its narratives. The Perspective may not lead to – let alone generate – a specific design but a semi-real design that recombines embodied and embedded knowledge to direct and support further transdisciplinary applied research. In addition, LO and XIANGVEI are positioned in the topic of cosmetics rather than as fringe issues. My Approach emphasises the generation of a collective vision from popular culture. These visions can be more fully integrated into a sustainable direction for humans to develop. Moreover, as a popular culture topic, it can be disseminated among a wider group of people, including the younger generations, who have a greater voice in influencing society in certain key ways.

For example, XIANGVEI could help the public understand the relationship between sustainability, embodied and embedded knowledge and sensory technology through its physical and digital prototypes and installation. Prototypes based on scientific and fictional imagination could be narratives of sustainability by connecting different kinds of disciplinary knowledge. The installation may help us experience scenarios directly if we were to explore XIANGVEI to further understand scentory futures. It could also mediate an approach and an option or instance of sustainable Life-Style-Form that connects humans with nature through sensory enhancement. XIANGVEI as a designed organ and part of our body may help us think of

alternative ways of perfume practice and make it local, embodied with nature and caring for nature to form a non-anthropocentric society. XIANGVEI may also suggest that wellbeing could come from multiple sensory interactions rather than achieving higher efficiency and faster and more robust human ecological conditions, as is the outcome of consumerism. This offers an example and a path to resist reductionism. New knowledge gathered about the sensory could offer directions and potential knowledge of sustainable futures and spread through the popular topic of perfume.

My research focuses on how the design process can change relationships between stakeholders from different disciplines and with different roles in society. I conduct design research projects with manufacturers and my design colleagues to produce knowledge related to sustainability by materialising the future. The XIANGVEI and LO projects cannot adequately discuss the future of human interactions, such as personal identities and social values linked to human interaction; however, the important roles of XIANGVEI and LO reveal and help us understand what kinds of interactions and relationships between different stakeholders can be built through design. My Approach may also be used to design artefacts that address future unexpected relationships between different humans from a posthumanist perspective (Shih, 2012), including men, women and lesbian, gay, bisexual, transgender, queer or questioning, intersex, asexual and more individuals who are not directly discussed in this research.

For example, through imaginary and speculative design, we can see the potential of alternative products that may not only serve as a replacement for unsustainable ones but also repair the damage to our planet in the context of climate change (Edeholt, Joseph and Xia, 2021): we could make compost products of organic waste that not only decrease carbon emissions but also maintain carbon as biochar to nourish soil for bacteria and other nonhumans. However, these kinds of products do not receive substantial investments in the capitalist model since they are not focused on promoting sales and the growth and consumption economy but need more resources to design and make. My Approach is one mode of informing the public that we need to build new relationships of degrowth and ecologically oriented economies by way of reconceptualising Life Styles. These mediated Life Styles may attract plural resources from different stakeholders – government, companies and bottom-up communities – to further design and make realistic products.

6.4.3 A Long-Term Sustainable Cooperative Design Approach

The Approach and Perspective may also be conceived as a hybrid of designer attitudes and social realities to understand sustainable transformation. The Approach could create a cooperative culture by rethinking new knowledge with designer attitudes and re-analysing design outcomes and social realities through creatively making (Rawsthorn, 2018). The transdisciplinary design research process and the speculative design results could reflect the manners, attitudes and vision of cooperative culture and may express the urgent hope of creating that

cooperative culture through performative and poetic design while illuminating the problems of dualist views and reductionism in contemporary society.

The Approach may be taken up to shape a discussion space between designers, scholars and manufacturers, allowing different people to enter into dialogue and critically review our future sustainable lives differently and collectively in a cooperative culture. During the making of the LO prototypes, collaborators took the initiative to make the LO smarter and interact more with the environment, even playfully. This is a mode of engaging participations in cooperative culture so as to face ecological crises optimistically and not only via dystopian narratives.

The diagrammatic schematic mediation of the Approach and Perspective may be viewed as providing some balance between humans and technology by exploring Eco-Cultural-Techno futures and in using all kinds of materials. Life-Style-Form transcends dualist views of humanity at many levels – nature and culture, human and nonhuman, real and fictional. Life-Style-Form reflects how humans and the nonhuman matter and how society and technological development matter. These issues of humans, the nonhuman and ecology could bring knowledge from different fields to design research as a platform for cooperation, forming a dynamic process that could contribute, for example, to sustainable responses to urgent and complex problems.

The Approach and Perspective emphasise a dynamic cooperation process to produce diverse knowledge and solutions to deal with the ecological crisis. Design itself would no longer be problem-solving or the generation of scenarios but continuous problem forming, problem exploring and rational and affective force formed in the development process to build new relationships and change our being and caring for long-term sustainability. This process is like *Taiji* and can create an atmosphere for societal transformations (Jullien, 2004).

Building plural cooperations is an ideal model. However, in reality, many tensions of duality and conflicts must be overcome to achieve human-nonhuman cooperation towards flourishing. We will face tensions between population growth and quality of life and economic growth and degrowth that need to be considered and resolved carefully to achieve common development for humans and nonhumans. Relational thinking reminds us that we can only partially achieve an ideal model and stand somewhere between the worst and the ideal. My Approach provides a relational perspective on these tensions and conflicts, and XIANGVEI's multisensory form and LO's cooperative style inform a starting point from which we can move towards ecological flourishing. The climate crisis and ideal ecological flourishing can be the background to each other, like yin and yang. Just as we think of each day as the last day of our lives, we can think of the meaning of life through the lens of death.

Considering all the points above, my Approach and Perspective may become a new kind of

sustainable design towards long-term sustainability. Next, I discuss future research and practice directions of my Approach in light of different tensions and address some visible actions in my future work.

7. Some Future Directions

War, energy and climate crises are all relational tensions in our lives. My Approach and its future applications must be confronted with these tensions, although I am mainly trying to reconcile the tensions between humans and nonhumans in this thesis. Applying my Approach requires trying to reconcile diverse tensions, such as academic versus practical, commercial versus conceptual design, global versus local and new versus traditional. However, these tensions are widespread and difficult to resolve, and many scholars have tried to moderate them. In this chapter, I present some anticipated applications of my Approach, provide practical actions to further illustrate my Approach and address the tensions referred to above.

7.1 Speculative Eco-Cultural-Techno Design Research

My Eco-Cultural-Techno Design Speculative Approach offers methods for thinking about ecological reliance and further flourishing by creating speculative but everyday products. This Approach may enrich ecological design and provide opportunities to transform market-driven industrial design, which ignores the cultural function of products (Dunne, 2005), into an ecological Life-Style-Form design that addresses the poetic, performative and metaphysical relationships between humans and nonhumans.

Design that addresses imagination and sustainable futures may need further research on speculations and anticipations (Auger, Hanna and Mitrović, 2021; Light, 2021); for example, speculative and anticipatory design may change its focus from ourselves to multiple species and address the bottom-up powers of imagination to reshape the social-political order that has led to unsustainable beings and ways of life. Amongst other means, speculative and anticipatory design may be taken up in more technical and poetic projects from an Eco-Cultural-Techno viewpoint.

Furthermore, the technologies in futures with new cultural meanings could be used as sustainable design materials to transform design from being a tool of reductionism (Ito, 2017) and capitalism (Klein, 2015) to redirect practice towards long-term sustainability (Fry, 2009). Under this view, futures design may be more research-based than a technologically specific application. By this I mean that futures design may be a part of the entire design process or industry and a supplement or substitute for or complement to existing user and trend research in design. Further, futures design may be a transformation of the design method prompted and informed by emerging technologies, sustainable goals and ecological crises.

7.2 Design Research Beyond Human-Centric Commercial Worlds

In November 2021, I encountered representatives of a Chinese perfume company at a commercial event on sustainable Life Styles in Shanghai, where I was invited to share the experience of the sustainable Life Style in Nordic countries. One outcome of this encounter was that the company expressed interest in cooperating with me and told me about its new approach to conducting user research for design. Like other companies, they use Big Data to build user models, predict user behaviours and provide personalised products (Le and Liaw, 2017; Matz and Netzer, 2017). This approach can strengthen reductionism that regards humans as data and only uses digital technologies for human-centric design. In my view, future design research with a perfume company may explore alternative scents beyond only the digital or biological to enrich the biological and cultural meanings of smell and rebuild relationships between humans and nonhumans. The next step may be to connect the knowledge from XIANGVEI to a commercial scent company – but only on such terms.

As an Eco-Cultural-Techno designer, I have seen that it is indeed possible to cooperate with this company and use my Eco-Cultural-Techno approach, especially when the Chinese government is urging commercial giants in China to be aware of the need for climate action. Most of China's commercial giants have set up sustainability departments that engage with environmental and social issues through their products. Our projected future research aims to build new relationships for creating changes between companies, computer scientists, neuroscience and biologists by making experimental design prototypes. The research outcome would be a fresh encounter with poetic and playful knowledge to explore the problems and potentials of Eco-Cultural-Techno futures. In addition, the outcome may be a sensory installation to facilitate a local scent lab in communities, rather than a perfume lab in a commercial setting, to explore plural meanings of flourishing cultures as conceived by designers, scientists and people living in communities. In this situation, I will explore ways to practically position futures design as a new kind of design consulting in China, with the aim of developing new relationships for long-term sustainability instead of ad hoc solutions.

7.3 Building Up a Life-Style-Form Lab

Lifestyle has been used as a marketing tool in business settings (Tomlinson, 2010), and lifestyle labs tend to be marketing-oriented and focused on branding strategies rather than experimental spaces. In this context, there is an opportunity to work towards more open-ended, experimental lab spaces and processes to build out relations between the technical, social and cultural regarding transdisciplinary and designer-driven sustainable futures. My intention is to build a future Life Style lab in China geared towards long-term sustainability. This lab may use style and form to inherit design vocabularies and reinvigorate them with new Eco-Cultural-Techno understandings, instead of Life Style being seen as a concern of elite life or different

forms of consumerism.

Through the notion of Life-Style-Form, the lab may not serve commercial companies' interests to develop and promote consumer goods with eco-materials. However, the lab may build a space between academic institutions, government and business, as in other ventures like SPACE10, an IKEA research lab on future sustainable living, to explore alternative ecological futures that respect and cooperate with nonhumans. In this setting, ecological futures may not be framed as linear solutions. Instead, ecological futures may create and offer diverse scenarios with poetic and symbolic design objects related to Life-Style-Form that amplify our feelings on alternative everyday living. Ecological futures may connect design and other disciplinary knowledge and practices to enlarge our world perception of long-term sustainability[42]. The lab still needs to develop more formats of design research as better media that can build a space of mutual understanding between design research, commercial practices and other academic disciplines.

Designers with different backgrounds and creative techniques may create different designs for the same issues, and speculative design tries to maximise future possibilities but carries the risk that design will be too optimistic or too pessimistic (Tonkinwise, 2015). By addressing multiple perspectives on design towards futures to prevent these risks, co-design brings anticipation studies to the fore (Light, 2021) and adds nonhumans as stakeholders (Lindström and Ståhl, 2015). Even though I discussed my design concepts with other designers, companies and ordinary people in my design research, there is a gap considering nonhumans in my research that emphasises the co-design of different designers with different backgrounds and creative techniques beyond the dualism of individual and collective. The designs in my research are set to explore the design approach, but they do not reflect the full image of cosmetics from an Eco-Cultural-Techno point of view.

In the future, my open-ended research results may be constructed by connecting design concepts from different designers on the same topic. The design implementation may adopt one concept but use other concepts as benchmarks. In this way, design implementation may avoid extremes and show a diverse range rather than a design selected within a narrow range. The lab may build a design tool to establish relationships between individual speculative design concepts on the same topics as a collective design process.

42 When I discussed my projects with cosmetics companies, I realised that design projects related to sustainable futures are still considered art projects that use design artefacts to build scenarios of sustainable branding strategies while ignoring the transdisciplinary knowledge available from design. In contrast, my approach seeks to be used as a company's decision-making approach that influences the direction of product development and raises awareness of new cultures.

7.4 Engagement with Nondualism Between Globalisation and Localisation

Many public or commercial installations in Asia show future scenarios with a specific solutionist view or embody Western mainstream or popular thought. For example, the McaM museum in Shanghai set up an emerging sci-tech artist award for the first time to provide residence positions and make an exhibition[43] of the residence works in 2021. I have visited the exhibition. The artists and designers come from around the world, and most works explore relationships between technology and nature. This exhibition reminds me of the complexity of globalisation in China. Many of the pieces in the exhibition were from Western artists, with a very brief Chinese introduction, and the exhibition soon became a check-in location for Internet celebrities. China presents many art and design exhibitions every year, and they seem to have become a commodity rather than fostering a mutual understanding between East and West.

On the other hand, some scholars from East Asia who embrace technology and posthumanism have become popular, like Yuk Hui, who built a network[44] to challenge the dualisms of thinking about East and West, technology and ecology and global and local to discuss local technological development. A variety of seminars took place in this network to discuss plural futures. Hui's concept of cosmotechnics needs to be discussed carefully regarding local technological development in China due to the complexity of the Eco-Cultural-Techno system. The Chinese government has ambitious plans to invest in carbon-related industries and research (Stanway and Xu, 2021). Meanwhile, the SKP-S shopping mall in Beijing, with fabulous installations that depict our technological human future, became the world's largest retailer by sales (Zhang, 2021). These installations appear to stand as one with the paradox between communist goals and capitalist dreams. These installations may be used to explore local technological developments to envision plural futures.

Plural installations could be one way to put different local futures together and think of alternatives beyond the dualism of East and West, perhaps thus allowing us to address the urgent common issue of climate change in a complex global context. Therefore, transforming commercial installations with local insights and stories of Eco-Cultural-Techno futures may provide a rich space for the Life-Style-Form lab to engage with the local public and raise questions about and describe potentials of emerging cultures and technologies to provoke a new sustainable way of living. Due to retail digitalisation, there is a demand in Asia to change commercial space into a meaningful experience space. This situation may allow the lab to conduct more design research projects to materialise plural futures through the Eco-Cultural-Techno approach rather than focusing on personal expressive art.

43 Available at: https://www.sohu.com/a/492837093121124789

44 Available at: http://philosophyandtechnology.network.

Climate change and pandemics require humans to cooperate to stay out of global troubles and develop a shared but alternative vision of survivable futures. However, we can see that various international conflicts persist while new ones emerge. This situation constrains the global issues that can be discussed. The proposed lab will be set up to emphasise cooperative relationships between humans (including different human races), nonhumans and AI. Perhaps this lab may go so far as to assume that design research could become a language for mutual understanding between different cultures through the materialisation process of artificial objects and their design process. I hope this lab will continue the goal of the designBRICS network, discussed above as a host and collaborator for my research: making designing a way of connecting continued communication between the Global North and South to deal with climate change and build up sustainable futures for all.

Auger and Hanna (2019) argue that these moves between local and global, marketism and degrowth design need to be seen critically and challenge design constraints from capitalism and conspicuous consumption in relation to imaginative, inclusive and sustainable design and relation between the future and the present. During an interview, Auger said the following:

> Speculative design has [also] become too associated with futures. Of course, speculating on possible futures remains one key strategy but far more interesting (from my perspective) are alternative presents – the reconfiguring of elements, motivations, structures or systems that exist in the world today.... Design essentially needs a revolution, a shift away from market-driven imperatives, and the constraints that these impose, towards more responsible approaches – this is where the most interesting speculative design projects are currently happening. (Auger, Hanna and Mitrović, 2021, p. 207)

7.5 A Cooperative Culture and Youth View

My two playful and interdisciplinary design research projects tried to connect the reality of cosmetics consumerism, radical ecological cosmetics and alternative ways of seeing and knowing current potentials. However, LO and XIANGVEI only reveal certain small parts of our futures. We still need more relational design or transdesign to help us think of more emerging cultural components of the reconfiguration of our global and local culture. LO and XIANGVEI did not penetrate more deeply into the pop culture of Generation Z but more calmly reversed the approach cosmetics from a consumerist culture to a culture featuring cooperation between humans and nonhumans. Generation Z may have elements of a more radical culture in the face of climate change to create a new political and social order without more constraints, beyond the world of LO and XIANGVEI. Future design education may need to develop more design approaches that can participate in the unfolding cultures of younger generations.

A cooperative culture also needs to be seen in a relational way. Cooperative culture here involves removing the constraints of cooperative possibilities. Cooperation between humans

and nonhumans emphasises unrestricted plural interplays rather than solely a capitalist mode of exchange. How to achieve long-term sustainability through cooperation arguably requires designers from younger generations to explore the world and themselves in design environments without the stifling constraints imposed by a market-driven society. We may further discuss the culture of young designers by asking questions about who to collaborate with, what disciplines to engage with, and how the exchanges of different cultures happen in design schools, studios and labs. These questions also mean that cooperative culture needs to be further discussed in the wider contexts of decolonising design (Abdulla et al., 2019; Schultz et al., 2018), between the poor and the rich, between the East and the West and between humans and nature.

7.6 Towards Future Actions

As I write in spring 2022, I have been negotiating and accepted the offer of a position at a new technical university in Shanghai that is part of the Chinese Academy of Science. This has been a welcome development that points to the time being right for such imaginary design work to be better connected to actual transdisciplinary research and educational practice.

The interview for the position gave me opportunities to think further about this research. During the interview, the interviewer asked me how I would continue my scent design research and cooperate with their neuroscientist on smells and computers. I think my doctoral research has already shown the potential to provide a bolder sensory experience through design focusing on the value of a new sensibility between humans and nonhumans. I plan to cooperate with the scientist to make prototypes that directly experience the different meanings of the environment through sensory channels so as to further understand the value of localisation, new consumerism models, and ecological Life Styles. Though the interviewer's background was in the sciences, there was no difficulty in understanding why I would conduct future research through my Speculative Life-Style-Form Design Perspective.

The interviewer mentioned a solar panel project that had no designers on the team and uses solar panels and sheep to create a new system to repair the desert and save human resources in western China. He thought this project had worked well and asked what the design role of transdisciplinary inquiry could be in this project. My answer was that my Eco-Cultural-Techno Design Speculative Approach would further investigate relationships between multiple intelligences and non-existent design as nonhuman to develop an alternative system and ask how we engage with the natural system under a cooperative culture. The interviewer and I agreed that design in transdisciplinary research could create new relationships and connect limited disciplinary knowledge through speculative making. Therefore, this thesis's character, content and exploratory status are key to generating dialogue with scientists to further understand why and how sensory design and multiple intelligence design will matter even more in the future.

During the job interview, the interviewers also mentioned that I would teach non-design students design thinking if I took the job. The idea is to use design to cultivate students' relational knowledge between science and the humanities to contribute to society and sustainable futures and to support them in making wise choices for their future research directions. These new attempts in a technical university may reveal how imaginary design can play a critically positive role in transdisciplinary cooperations for sustainable transformations.

More importantly, we need to think of what kind of transdisciplinary cooperative design should be launched in a climate-urgent and post-pandemic era. We need a new social and political order that no longer relies on consumerism to drive economic growth. In that new order of long-term sustainability, our material world offers a sustainable and cooperative assemblage of diverse humans and nonhumans. Consumption is not linear or the circular process proposed by advocates of a circular economy approach but a dynamic, Eco-Cultural-Techno, poly-relationship process between humans and nonhumans that contributes to human existence. When we have such a dynamic and relational process, we may have a wider space to explore richer meanings of human existence and sustainable flourishing.

8. Conclusions

8.1 Main Matters

This thesis addresses the crisis of climate change and the challenge of sustainability through a speculative and imaginary design approach. It does so by connecting design making and relational analysis through the development of two interconnected cases and two analytical framings. Through speculative design, the practice-based inquiry explores plural relationships of Eco-Cultural-Techno futures by way of playful, quirky attitudes and relational thinking. This extends to both the designing and the analysis.

My overall goal was to see how design may be used to alter the relations between human and non-human in shaping alternative takes on understanding relations of the ecological (biodiversity, environments and diversity of wellbeing), cultural (plural participants, use scenarios and creative design futures) and technical (materials, artefacts, tools, platforms and criticality uses).

Speculative design was taken up as a means of exploring uncertainty, change and the potential of developing imaginary and prospective views on thinking beyond current models of overconsumption and resources extraction based on endless models of growth in the wider context of climate change. Given this backdrop, I focussed on the domain area of cosmetics and design as a way to elaborate the relations between the ecological, technical and cultural in looking into imaginative futures design. I did so through two speculative design cases.

Using an interplay of theory and design practice, I developed an Eco-Cultural-Techno Design Speculative Approach and a Speculative Life-Style-Form Design Perspective. I developed them as means to break dualisms – human and nonhuman, East and West and technology and nature – by connecting three core aspects: ecological, cultural and technological. The Approach and Perspective aimed to understand the current unsustainable relationships and anticipate some potential relationships of sustainable futures in design-driven ways. Their goal was to build up an analytical research frame and a posthumanist application to support studies on Eco-Cultural-Techno futures and facilitate an atmosphere for sustainable transformation.

In order to develop the design works and the related analytical aspects of the study, I focussed on relations between what I dubbed Life Style and Life Form from a speculative posthumanist viewpoint. Concerning culture, the former refers to the values, actions and behaviours involved in the interactions between humans and nonhumans in ecological and technical environments. The latter is about diverse views of physical components and construction

development, from biological to artificial, in the context of climate, culture and the environment.

Overall, the thesis suggests that a speculative and relational Eco-Cultural-Techno posthumanist design approach may help us better appreciate the importance of the imaginary in understanding aspects of climate and the environment and enact changes directed towards long-term sustainability. It draws attention to the role of relational thinking and designing to achieve that goal. It also emphasises a plurality of elements, participants, knowledge of systems and interactions. It is important here to look to ways to communicate and facilitate transformations that need to be appreciated for their complexity.

My speculative and diffractive research process through design has sought to reveal and conceptualise some of the complexities, difficulties and urgency of climate change and the Anthropocene. My two works, as part of practice-based research, were neither utopian nor dystopian in the binary sense. I crafted them in a mode of serious play and offered them in a spirit of ludic, joyful, quirky, and even weird possibility. The works revealed the complexity, tensions, strangeness and difficulties of climate change and showed that open-ended design results might be included in persuasive and aspirational actions and aspects of transformations. I also see the works and their design as alternative way of being to what I have characterised as mainstream consumerism based on infinite models of growth. In doing so contextually, I have engaged with the strange, the complex and the difficult in climate change and Covid-19. In such contexts, I have worked with the imaginary and through speculative inquiry posed potential ways of conceptualising alternative futures through design linked with relational thinking.

On reflection, my Approach reminds me of the ancient Chinese game Mah-jong (Culin, 1924). At the beginning of the game, all the cards or ties are chaotic. Everyone has a set of cards in their hands. Each player simultaneously takes one card and plays one card when it is their turn. Winning the game requires that the different cards in hand form a specific relationship. Players keep anticipating the cards encountered in future actions and the relationships between the cards that will eventually win. The card relationships depend on other players, and new cards are picked up randomly. Compared with Mah-jong, my Approach combines different elements from the Perspective, like cards for specific Eco-Cultural-Techno relationships through speculating and anticipating. My achievement is to contribute to thinking on long-term sustainability through the multi-relational charting of Eco-Cultural-Techno relationships in the context of chaos and climate change. The process of playing Mah-jong always takes place with the tension between certain and uncertain, and its making relationships between cards are joyful, playful and exciting for the players.

As a whole, the game may be seen as a cultural metaphor for me to think of my Approach further at the end of this exegesis. This metaphor suggests that design may need to be playful

and bold to imagine, speculate and anticipate new relationships through different designs, which could find alternative human ways of being with unique actions from rather than out of climate chaos. Next, I conclude with my focus, outcomes, the new knowledge in my research and their future directions and potentials.

8.2 Research Focus and Outcomes

This thesis has inquired into emergent framings and practices around speculating on design, Life Styles and Life Forms. The core research problem has been to investigate what a speculative design study of Life Styles and Life Forms may contribute to the further shaping of a relational perspective on ecological thinking regarding the complexities and contexts of climate change and potential transformative practices for long-term sustainable futures.

Overall, I have adopted a relational ontological approach to design and futures (Brassett and O´Reilly, 2021b). To reiterate, a relational ontology seeks to use relationships to reveal the being, existing and becoming of nonbinary objects and subjects. Brassett and O'Reilly (2021a) write that

> if we are to see anticipation as being concerned with the future in order to create a different present, being engaged with the darkness of the future even, then this is in order to make an intervention today. This concern is a call to present action. Those who anticipate must simultaneously occupy a position outside their own time and see it in all its darkness – thus becoming contemporary – and do so in a manner that stands outside future possible times too. They need the courage to anticipate their own contemporariness, their own irrelevance, in order for it to be created and involved in an on-going creation. (p. 252)

I adopt a relational worldview to engage with the contexts of climate change as critiques of growth models and consumerism for design together with calls for urgent actions and means to motivate an engaged transformation. I have further positioned this Approach through design-driven perspectives to disentangle some of the complexities of the framings of the Anthropocene to contribute to conceptualisations that inform the further development of approaches to long-term sustainability. I have explored the relations between Life Forms (biological, human and computational) and Life Styles (coordination of actions, behaviours and meanings) to understand and shape relationships between human and nonhuman participants and thus better understand the issues and challenges of climate change.

The study was conducted in the mode of speculative design research via two design projects of my own. As heuristic cases, the projects have been situated within and informed my research reflexively. I have taken up future scenarios – including the ecological, technological and cultural – to anticipate potential ways of sustainable future living for humans and nonhumans. These views and their speculative and inventive methods are discussed and offered as opening the potential for appreciating climate change's challenges and dilemmas. They are proposed as

possible paths towards reconceptualising long-term sustainability by focusing on design imaginaries and relational thinking in the present.

The first of two related sub-questions I posed sought to engage with ways in which exploratory artefacts in speculative design research might be configured in the present to help us shape and understand future visions and relationships between humans and nonhumans, society and the biosphere in support of long-term sustainability. In the research, I took up future heuristic scenarios concerning cosmetics to anticipate the potentials of ways of living that might contribute to appreciating the characteristics, challenges and dilemmas of climate change and long-term sustainability. In so doing, I have explored the relations of wellbeing for all human and nonhuman Life Forms and Life Styles with the aim of seeing them flourish in nonbinary relations.

My second sub-question was oriented to seeing which posthuman qualities, characteristics and heuristics of Life Forms and Life Styles in the speculative design of hybrid artefacts – ecological, cultural and technical – might contribute to both human wellbeing and wider ecological flourishing in the context of sustainable futures. Here I focussed on the sensory Life Form and cooperative Life Style relations. The former refers to multiple senses as needed to enhance our understanding of the nonhuman and the environment. The latter encompasses eco-cooperative relationships.

Regarding my interest in cosmetics, I centred on sensory Life Forms because the sensory is a biological affordance and ability for all living organisms that is too often ignored by capitalist products and consumer development. Attention to the sensory properties of organisms, human and nonhuman, highlights the need to attend to sufficiency and diversity; that is, environments rich in relations of the biological, human and technical, rather than being saturated with mono-cultural efficiency and functionalist utility. When focussing on cooperative Life Style relations, facilitators and the facilitation of care and related support are involved. These are included not only to perform specific human goals but also to shape and enliven the wider practice of care directed towards flourishing that incorporates human and nonhuman actors and systems.

8.3 Shaping New Knowledge

The research adopted a relational onto-epistemological frame. It concerned climate and sustainability, including posthumanist views, critical climate science and discourses, environmental care and long-term ecological survival and techno-cultural critiques of consumerism and materialities within emerging political economies of use, exchange and resource scarcity. As a result, the thesis has developed new knowledge in the following ways:

A conceptual design speculative relational approach has been developed to inform and support critical and imaginary-centred insights, atmospheres and analyses on the broad issue of climate change.

A specific Life-Style-Form perspective has been charted for speculative inquiry related to life, change and flourishing.

Engagements with designer-driven relational thinking allow for the connection of different types and statuses of knowledge to be realised heuristically challenge dualisms in industrial and post-industrial economies based on models of growth that deplete the environment.

I now turn to the ways that speculative designing and researching may be actionable for possible futures and alternative presents.

8.4 Connecting Speculative Designing, Research and Actionable Futures

One may wonder whether speculative design-based research has any wider application into design and research, teaching and change. Speculative design has been critiqued as only a materialisation process and sometimes as a creative response to a current trend that is not well equipped to challenge structural problems and broader political, technological and biological issues that construct the design context (Tonkinwise, 2015; Ward, 2021); it is also Western-centric in its of lack of plural cultures and audiences in current design research (Martins and Oliveira, 2014; Tonkinwise, 2015; Ward, 2021).

Despite this criticism, speculative design has become a part of research-based practice through imagination and plural speculative design approaches (Mitrović, Hanna and Helgason, 2021). Lockton and Ranner (2017) write that 'speculative design approaches, in facilitating a pluralistic treatment of futures, can help to open up, and explore variety and complexity in human behaviour. We cannot predict and plan human behaviour as if people are engineered components, so we can only speculate on actions' (p. 494).

With attention to the conceptual and the speculative, design through plural media, digital stories, discursive objects, installations and the like can provide critical alternatives and potentials to anticipate futures, rethink the present and prompt public awareness, actions and dialogues. This broad understanding of speculative design may help designers and design researchers who work in educational institutions offer courses and cooperate with scientists to explore futures. It may enable the opening imaginary and critical spaces with non-profit organisations to provide consulting regarding alternative situations and with the business

sector to help companies rethink and choose preferable futures. The goal of these different design research experiments, manifestations and practices is not to avoid or evade but to look further into the complexity of our human challenges. Then, we need to think of further actions to change our society to respond to challenges like climate change quickly.

Designs may provide actions and behaviours with particular strangeness and a little weirdness for seeing and knowing new directions beyond a current capitalist world. As Mark Fischer has written, 'the weird thing is not wrong, after all: it is our conceptions that must be inadequate' (2016, p. 15). We live in a market-driven and unsustainable society. Harmful human behaviours and actions have become normalised for feeling satisfied and happy. The quirky, unexpected and weird behaviours and actions provided by speculative design may offer strange sensations and experiences that may contribute to scaling up our understanding of reality and the unknown terrain of design directions.

In addition, in response to critiques about the privilege of speculative design, the imaginary materialisations from posthumanist and Eco-Cultural-Techno views may provide dynamic views and processes with which to think of nonbinary human concepts: no gender, class, country or race. The strange yet connected qualities of such a posthuman approach to design may provide an uncommon sense of experiencing potential plurality. The materialisation through imaginary and speculative design in an offbeat and playful way may form a loop or a transformative process between sustainable futures and our actions by creating new relationships that challenge problems in consumerist cultures.

My Eco-Cultural-Techno Design Speculative Approach offers a relational framing of how human and nonhuman relations and their actions individually and collectively could be seen to contribute to sustainable communities, societies and cultures in the future. It may provide a way to see as-yet unformed relationships between humans and nonhumans through human conditions, behaviours and actions. Yet these latent relationships may be political, non-Western-centric and nondualist. This makes them hard to discuss through the present realities of a business-as-usual mode: they are counter-designs that offer potential alternatives that require further work to be connected into deeper socio-material practices in an ecological context. New actions from speculative design may then further inform the consequences of future human behaviour and lead us to understand how to achieve sustainability through alternative actions.

These designs, such as XIANGVEI and its calls for scentory actions, will need to be a type of transdesign of multisensory, multimodal and multispecies components and participants to achieve sensibility between human, nonhuman and the environment. The smell of wildfires and dead animals in a city after a flood may raise questions about consumption and environmental and urban policies and practices. They may also suggest and offer different orientations

for interacting with scents for sustainable futures. I believe we need strange, playful and quirky scent actions and plural actions as an integral part of sustainability facilitated by design to respond to climate change and the Anthropocene and facilitate urgently needed sustainability. We need to think creatively and be inspired to refuture existing relationships and systems that will otherwise lead us to extinction.

8.5 Creativity and Future Flourishing

I have mentioned above Haraway's notion of staying with the trouble. We are living in an Eco-Cultural-Techno storm, in which we sometimes feel that we cannot deal with troubles and can only stay with and be responsible for them. In this storm, our consciousness is changing. We have reflections on the current dualist views and reductionism. We have realised that human development is natural, cultural and technical, guided by long-term sustainable futures and common development with nonhumans. The Eco-Cultural-Techno Design Speculative Approach may help us see the transformations that will emerge after the storm. These transformations are about our being, new Life Forms and caring, which involve new relationships with nonhumans, and about new Life Styles.

We continue to make new concepts – the Anthropocene, sustainability, posthuman and post-pandemic – to address the urgent issues and challenges we encounter and our ongoing need to work to transform futures. This thesis has worked to create a transdisciplinary connection between these concepts. Through research by speculative design and related analysis, my work advocates sensory and cooperative futures towards long-term sustainability and a conceptual approach for making them. The Approach, together with the Perspective, may offer some design research-located starting points for speculative Eco-Cultural-Techno design to expand knowledge and our ability to respond creatively to urgent planetary challenges.

As anticipatory creatures contributing to and experiencing climate change and other complex challenges, designers, designer-researchers, the design profession, other specialists, citizens, companies and policymakers may all benefit from sharpening their speculative abilities through design. I suggest that there is a need for further conceptual work on speculative design that connects concepts and actions and shifts design creativity and futures design work back into the present.

All in all, I see that such a mode of refuturing and shifts in movements into action in the everyday and immediate world may help us better connect the ideational and imaginary with the pragmatic and critical. In the long run, research-practice-based design projects may be enhanced by the inclusion of a focus on Life Style and Life Form as dynamic and critical practices. Together, they may contribute to ecological flourishing and to forms of multispecies coexistence that support and help realise long-term survivable and sustainable ecological futures.

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DESIGN FOR QUALITY LIFE

Speculative Transformation of Lifestyle

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ABSTRACT

Since climate change has become a tangible and serious issue that humanity has to face, more and more disciplines are evolving to address this field, including design. Design, especially product design, is regarded as a discipline that promotes consumer consumption. Design itself is a problem in the context of climate change. As new design approaches such as social innovation and transition design try to deal with issues such as climate change, designers sometimes lose sight of their aesthetic role. The core question of this challenge is how to understand the designer's creative and aesthetic skills in these projects. In this paper, I will demonstrate why lifestyle transformation could be a promising practice space for designers by analyzing the current situation of transformative design and speculative design and discuss the relationship between these. By this means the study will inform a more sustainable direction into which designers can transfer their creative and aesthetic skills.

KEYWORDS

Transformative Design; Speculative design; Lifestyle Transformation; Narrative Prototyping; Aesthetics Experience

1.INTRODUCTION

Climate change requires us to question the effect and aims of free market ideology in relation to the limits of natural resources (Klein, 2015). In this context, designers are embracing new tangible spaces to address problems that climate crisis brings forward. Since the carrying capacity of the planet is distinctly limited, less developed countries are constrained in the extent to which they can follow the old industrialization route developed countries adopted before so as to achieve the what is known as the "standard life" (Dietz & O'Neill, 2013). At the same time, it seems hard to justify directing developed countries to consume less and to restrain consumption, given the consumption-driven economic model (Hickel, 2017) unless the terms of the debate are changed. It is time for designers to rethink what standard life should look like and whether the standard life means a quality life.

First, designers need to understand the meaning of quality life and take efforts to address overconsumption through meeting needs instead of satisfying desires. Meeting needs (such as psychological support and protection, emotional, intellectual, and physical communication, participation and autonomy) does not require goods and services from the market (Kamenetzky, 1987), which instead is often designed to satisfy desires. It is easy to ignore the fact that a high quality life should properly be one that is determined by the interaction between people and the connection between individuals and environment, rather than the things we have. Ehrenfeld (2013) wrote that the current collective model that the world operates under, and our understanding of human behavior, drives an unsustainable, unsatisfying, and unjust social and economic machine that dominates our lives. To shift the pendulum towards a new way of living, he describes a new way, driven by being and caring rather than by having and needing, a way based on collective wisdom and life experiences. Due to the importance of the interaction between people, and the connection between individuals and environment, a well-connected society can be seen as the main characteristic of a quality of life. So, design needs a more socially focused perspective.

In general, existing approaches to deal with climate change aim to raise public awareness and to call for individuals to reduce, reuse and recycle(McDonough & Braungart, 2002). The normal design process

to handle these approaches is more or less problem-oriented. But in this way, design itself as a problem-solving activity loses the ability to deal with wicked problems (Rittel & Webber, 1973) like climate change. A paradox comes out then. The clear aim to design for solving a concrete problem makes the design process efficient indeed. And mostly, high efficiency is very much the goal in the 'business as usual' society, but the pursuit of high efficiency might result in a loss of focus on the broader context. What else is needed?

In contrast to efficiency, *sufficiency* is a core idea of resilience thinking (Walker & Salt, 2006), i.e. thinking about the ability of a system to absorb disturbance and still retain its basic function and structure of a social-ecological systems (bid). Contemporary societies tend to think of environmental issues as related to isolated unsustainable practices for the environment and thereafter focusing on policies that can mitigate that issue in isolation. This reflects the fact that we are lacking in resilience thinking and what arguably could provide a new vision of sustainable design. To illustrate this, designing for efficiency in order to 'reduce, reuse, and recycle' is typically the way chosen to reach a sustainable solution. But, in resilience thinking, that "design-for-efficiency" is not an adequate solution for long term sustainability and the resilience it requires. Society (and designers) could instead ask themselves if we really need the new or changed product within the ecosystem as a whole. Moving from efficiency to sufficiency, the design methodology could potentially benefit from moving its focus from the products, per se, to scenarios that also explores future and alternative contexts of use.

The paper first outlines the relevant design concepts, transformative design and speculative design, which could make this design method transformation happen. Then this paper will discuss the relationship between these two design concepts and show why lifestyle transformation could be a promising practice space in the future for designers. The last part will explain why aesthetics experience could be a powerful tool for speculation and future lifestyle transformation, and designers' creative and aesthetic skills are still crucial in the new design area.

2.TRANSFORMATIVE DESIGN AS A STRATEGY FOR WICKED PROBLEMS

2.1 THE CONCEPT OF TRANSFORMATIVE DESIGN

A wicked problem is a structural problem rooted deeply in modern social production and consumption patterns (Rittel & Webber, 1973). Since design is more than the simple activity of solving problems, giving an 'ideal' to the world (Nelson, 2012), design processes, through their negotiative role, can handle wicked problems. At the same time, there is a need for transition to solve the root of problems by changing social-technical systems. Fry (2008) argues that design can redirect development for a transformation to change social-technical systems. He proposes that sustainable design could be a 'redirective practice' which is able to direct society away from deepening the disaster of unsustainability and towards the integrative character of sustainability (ibid).

Transition design advocates the "reconception of entire lifestyles" (Irwin et al. 2015), with the aim of making them more place-based and convivial (Ivan Illich, 1973) and participatory and harmonizing them with the natural environment. Transition design focuses on the need for 'cosmopolitan localism' (Manzini 2009; Sachs 1999), a lifestyle that is place-based and regional, yet global in its awareness and exchange of information and technology (Irwin et al. 2015). The character of transition design seems to be well-suited to dealing with the wicked problems of sustainabilility.

Transformative design is a similar concept to transition design. Today Transition Design and Transformative Design become two concepts that often, but not always, are used in more or less the same way. Tentatively I start with the understanding that the two concepts can be distinguished as follows:

- Transition is the 'trajectory of change' (Fry, 2008). Consequently Transition Design is design that facilitates or enables us to take steps towards a certain goal. In this case towards a more long term sustainable future.

- Transformation is change or even 'radical change'. Consequently Transformative Design is design that facilitate or enable radical transformations e.g. by inspirational products, visions and scenarios that make our ultimate goals "thinkable"(Wood, 2016).

The difference is that a transition can be meant as an incremental change whereas transformational change is understood to be a change of considerable magnitude.

2.2 TRANSFORMATIVE DESIGN IS INTENDED TO BE FUTURE ORIENTED

The future-oriented vision is essential in transformative design. The development of future visions is dynamic and grassroots-based. This emerges from local conditions vs. a one-size-fits-all process, and remains open-ended and speculative. This type of vision is circular, iterative and error-friendly and might be used to envision radically new ideas for the future that serve to inform even small, modest solutions in the present. Visions of sustainable futures can provide a means through which contemporary lifestyles and design interventions can be assessed and critiqued against a desired future state and can inform small design decisions in the present.

Wood (2016) built up a new design model - design for micro-utopias – to deal with an unattractive world caused by democratic and economic systems. This is a typical approach towards transitions. The transitions could be towards a more attractive world with aesthetic experience. We lived in a dysfunctional world which is characterized by the terms- 'right and responsibility' 'overshoot' 'efficiency' 'customer-friendly' 'cynicism'. We are facing a mounting state of solipsism which is caused by individual-oriented economics of consumption, narcissism, consumer-centered society, designing to increase appetite or desire, and busy lifestyles with hectic careers. One of the dangers of living in a supposedly fact-oriented culture is that people begin to depend on the deductive, rather than the inductive or abductive. Thus, imagination, or the counter-factual, would have to become far more important to our culture. All these dangerous scenarios provide an opportunity for the design of micro-utopias. Wood argues that in order to develop desirable and ecologically sympathetic living styles, we will need to transcend the conventional problem-oriented approach. We need to develop a culture that will help us to cultivate new micro-utopias. Utopian living system is a harmonious network, and a harmonious network means that all its parts have an innate purpose to contribute to the harmonious functioning of the whole, and they move naturally toward their proper places in the universe. Harmony is the principle of aesthetic experience (Parker, 1920). The future utopian living system has the side of aesthetics experience illustrated by designers' aesthetic skills.

2.3 TRANSFORMATIVE DESIGN AS AN APPROACH OF EVERYDAY LIFE

The transformative design approach is complex and could use many existing design approaches such as design for services and design for social innovation. One critique of service design is that it is not very aesthetic, since it is intangible. There are many origins of the transition concept such as sociotechnical transition management theory, living systems theory, future study, indigenous wisdom, cosmopolitan localism, and social practice theory. Various design approaches have diversified our ability to imagine

the future, and inspire short, mid- and long-term solutions. Examples include scenario-based initiatives such as Manzini and Jegou's *Sustainable Everyday* (2003) and Jonathon Porritt's *The World We Made* (2013). Transition designers (Irwin et al. 2015) are suggested to work in three broad areas: developing powerful narratives and visions of the future or the 'not yet' (Bloch 1995; de Sousa Santos 2006), amplifying and connecting grassroots efforts undertaken by local communities and organizations (Penin 2013; Manzini 2007, 2015), stepping service design or social innovation solutions within long-term transition solutions, and working in transdisciplinary teams to design new, innovative and place-based solutions rooted in and guided by transition visions with aesthetic experience.

Within social practices, exploring processes of transformation can help people understand the potential of change (Shove et al. 2012). The Social Practice Approach – derived from Giddens' structuration theory- does not start from the individual attitude or norm for predicting the environmentally friendly behavior of an individual, but instead departs from the actual behavior practices that an individual shares with other human agents (Giddens 1984; Spaargaren 2001). This means the only way to bring about sustainability transitions is to change the values or belief systems that are guiding individual behavior. Different aesthetic norms, respecting indigenous life traditions and slow life with quality, can be perceivable elements in the value or belief systems to sense the transformation.

Social innovation (Manzini, 2015) is an activity that emerges from the creative recombination of existing assets (historical heritage, traditional craftsmanship, and accessible advanced technology), which aims to achieve socially recognized goals in a new way. Real-world projects show that visualization is an effective social innovation tool during the scenario-building, stimulating reactions and interactions between different potentially interested actors, facilitating social conversation in the different phases of the co-design process, and offering prototypes, small-scale experiments, or even full-scale pilot projects (Manzini, 2015). The designed objects with aesthetic sensibility could facilitating social conversation more engaged with people.

3.TRANSFORMATION OF SPECULATIVE DESIGN

3.1 FROM CRITICAL DESIGN TO SPECULATIVE DESIGN

Many new design methodologies emerge for dealing with wicked problems in contemporary society by means of sustainable solutions. From a transformative perspective, the design industry should change its focus from an (individual) human-centered design approach to a society-centered approach (Jonas et al. 2015). This is because a human-centered design approach aims to design for the wants of consumers, as a promotor of consumption. Often are objects designed not to be treasured, but to be thrown away (Twemlow, 2017). Critical design addresses with this situation. Critical design is a self-aware and subjective practice of interpreting, discerning among, encouraging, or resisting the various aesthetic, moral, environmental, or social repercussions of the ideas, activities, and outputs of the design industry (ibid).The critical design practice has grown in popularity within the industrial design discipline over the past decade – particularly in the context of design research and postgraduate education (Malpass, 2017). Critical design´s aesthetic element is not to be overlooked. It deals in weirdness, incongruity which is what standard industrial design avoids.

Malpass classifies critical design into three different groups: associative design, speculative design, and critical design in the industrial design domain (Malpass, 2017). Speculative design is concerned with the projection of sociotechnical trends, developing scenarios of product roles in new use contexts. It makes scientific theories and the cultural implications of science perceptible in different ways and shows them in everyday contexts. Dunne & Raby (2013) propose speculative design that "uses the idea of

possible future scenarios as tools to better understand the present and to discuss the kind of future people want, and, of course, the kind people do not want". The form of speculative design thrives on imagination and aims to open up new perspectives on wicked problems in order to "create spaces for discussion and debate about alternative ways of being, and to inspire and encourage imagination to flow freely". The function of this speculative research is not to provide techno-aesthetic solutions to pre-defined problems or to 'domesticate' technical inventions, but rather to mobilize design as a "catalyst for social dreaming" (ibid.). Indeed, speculative design is focusing on an alternative future, rather than on predicting, forecasting, spotting trends or extrapolating. These have been proven wrong repeatedly. We can see many speculative design projects in synthetic biology research like engineered plants for entertainment or living architecture materials (Ginsberg et al. 2014). These products change the future behaviors of consumers. Thus, designers could use speculative design to reflect upon and open up the field of possible futures for future behavior change rather than concentrating on single, linear, deterministic visions.

3.2 SPECULATIVE DESIGN AS FUTURE SOCIAL SCINENCE

Recently, some scholars from different disciplines have begun research about speculation itself and developed alternative approaches which take futures seriously as possibilities (Wilkie et al, 2017). They believe speculative research is a collective and transdisciplinary task and demands new habits and practices of attention, invention and experimentation. As in the fields of architecture and design, forms of visual and material speculation provide an alternative way of conceptualizing and directing the role of aesthetic and technological design practices, urban visions, propositions and outcomes (Dunne and Raby, 2013 Lang and Menking, 2003; Rao et al 2015; Wilkie, Michael et al. 2015; Zegher and Wigley, 2001). Compared with other forms of speculation not from design, the tangible form could be an interesting playground for different disciplines and a better medium for the public where people could participate in and sense the possibility of transformations through physical objects. Consequently, researchers from the social sciences have increasingly cooperated with designers to carry out speculative research.

Social sciences have become preoccupied with the constitutive, 'performative' and 'non-representational' dimensions of research methods as well as the acknowledgement and inclusion of non-human agency (Back and Puwar, 2012; Law) because of rapid development of technology. Specifically, anthropology become a renewed, open and future-focused approach to understanding the present, anticipating the unknown, and intervening in the world (Salazar et al. 2017). Furthermore, some scholars (Gunn et al., n.d.) combine knowledge of design and anthropology as a new concept – Design Anthropology. The Design Anthropology method is based on collaboration, intervention, and co-creation, instead of observation and interpretation in line with more traditional anthropology methods. The conceptual and methodological frameworks of Design Anthropology have to move beyond basic notions of causality and the projection of statistical trends into the future in order to fully capture the emergent character of the present. This could make the design industry rethink trend study consultant services and develop a new type of future design lab. Speculative design is a way to do social research and make a cultural future with more aesthetics focus.

4. SPECULATIVE TRANSFORMATION OF LIFESTYLE

4.1 TRANSFORMATIVE DESIGN PRACTICE SPACE: LIFESTYLE

"Lifestyle" could be a holistic way to describe everyday life. Because of the 'openness' of social life today, the pluralization of contexts of action, and the diversity of 'authorities', lifestyle choice is increasingly important in the constitution of self-identity and daily activity. Reflexively organized life-

planning, which normally presumes consideration of risks as filtered through contact with expert knowledge, becomes a central feature of the structuring of self-identity. A possible misunderstanding about lifestyle as it interconnects with life-planning should be cleared up right at the beginning. 'Lifestyle' refers also to decisions taken and courses of action followed under conditions of severe material constraint; such lifestyle patterns may sometimes also involve the more or less deliberate rejection of more widely diffused forms of behavior and consumption (Giddens, 1991). Lifestyle is disclosed by coordinating actions, by determining how things and people matter, and by being what is transferred from situation to situation(Spinosa, et al 1999). The matters between things and people could be influenced by aesthetic experience, and harmonious actions could strengthen aesthetics experience.

Everyday life is viewed as a potentially powerful, transformative space (Lefebvre 1984; Gardiner 2000) where transition designers explore ways in which basic human needs are satisfied locally, within economies that exist to meet those needs (Max-Neef, 1992; Illich, 1987; Kamenetsky, 1992). A sustainable society should make people experience a good quality of life. Lefebvre's emphasis on the quality of life (Lefebvre, 1984) will have even more appeal to those who currently live with the problems of inflation, unemployment and dwindling natural resources. Focusing on the quality of life, Lefebvre's critique affirms the importance of love, independent and creative thought, free time, and of meaningful work. He argues for the freedom to understand existing conditions and the need to submit these conditions to the principle of enhancing human life. More particularly, many scholars have explored the nature of everyday life. Shove and Trentmann (2009) argue that social movements are trying to slow down the speed of life, campaigning for a new 'simplicity'. In this view, material civilization in affluent, wealth-oriented consumer societies has been spinning out of control, and the pace of life is becoming too fast for personal wellbeing and environmental sustainability. Time is about coordination and rhythm, but it also involves material, emotional, moral and political dimensions and the basis for all academic depictions of cultural difference. I see all these as organised by an aesthetic sense. Different lifestyle has the different aesthetics. The policy like Soviet-style architectures always influences lifestyle, and everyday practice will go through the material world and produce emotion under the style. Controlling the pace of time was the foundation of the Fordist revolution and later movements towards scientific 'efficiency' in Taylorism (Shove, 2009). Individual life paths are characterized and punctuated by collective goals. Practices of time could be a space for transformative design to a slow life.

When we design for future quality life which is entirely new for people, the difficulty is to make the people accept and enjoy the alternative living scenarios, while the aesthetic experience could be a sensory engagement for the life transformation.

Aesthetics is a difficult word to give a precise definition, tackled many scholars for two millennia. Aesthetics experience has different concepts in western and eastern culture. In contrast with the aesthetic experience in the Anglo-American tradition, the aesthetic experience in Asian cultures are more concerned with activities like normal activities in daily life beyond traditional genre, aesthetic as a moment experience, in western cultures (Shusterman, 2010). Also, the aesthetic experience in Asia reflects the experience of the artist rather than the spectator which is different with the reflection based on the spectator in western culture (Shusterman, 2010). Japanese tradition's concern is with aesthetic emotion not only in connection with nature and everyday life but also as the emotion of the artist. Moreover, Harman (2017) tries to give a formalism in aesthetics in his theory OOO (Object Oriented Ontology). OOO divides everything into two categories real object and sensual object (HARMAN, 2017), and both objects have their qualities. The aesthetics experience is produced by the interaction between real object and sensual qualities. Based on the above definition of aesthetics experience, designers could use their lifestyle artifacts through imagery to create aesthetical experiences with

grounded meaning in human activity to bring people into a sustainable lifestyle. Meanwhile, lifestyle artifacts could strengthen the symbolic characteristics which create imagery to make people reach the future lifestyle.

4.2 NARRATIVE PROTOTYOING AS TOOL FOR LIFESTYLE TRANSFORMATION

Speculative designs act as a form of vision and argument that is established through the design of objects and through the communication of an object's narrative of use. In other words, speculative design uses 'context transfer', 'hybridity', and 'technocratic visualization' (Malpass, 2017) as means to achieve defamiliarizing effects that provoke the user to engage in meaning-making and provoke thought through the object's design. Normally design speculation is achieved through processes of making, production, scenario building, and storytelling. Meanwhile, storytelling and prototyping of scenarios could influence the sensual qualities (Harman, 2017) which is relevant to aesthetic experience. Thus, the narrative prototyping should have both tangible and intangible layers.

Prototypes could be used to inspire new ideas, demonstrate problems and test solutions (Gengnagel, 2016). Prototypes for the future produce a picture of a later product by combining technical, use-specific, and aesthetic requirements. A collective understanding of the use of technology enables the requirements of future technology to be determined. Prototypes in speculative design could be a way of exploring the relationship between users, objects, and the systems that they exist in. Prototyping becomes a commonplace form of communication and interaction for co-prototyping and becomes prevalent as a new medium in many areas of daily life (Kimpel, 2016). The result of the co-prototyping provide descriptive and visual information for a technical realization. Thus, co-prototyping could be used for transformative design, but this requires, in general, another interpretation, and transformation to traditional design prototypes.

Storytelling is well-developed in service and interaction design. Stories are a powerful tool in user experience design which can help designers understand users and their experiences better, communicate what they have learned, and use that understanding to create better products (Quesenbery and Brooks 2010). The User's Journey (Lichaw, 2010) for storytelling is also a tool and a framework for the design process. Stories can be helpful at many points in a process: collecting input, analyzing data, creating new designs, evaluating a design, and sharing insights with colleagues. Narratives and storytelling could be a concept and tool to stir emotions, build empathy, articulate values and convey action in design process. Narrative can also be essential part of innovation (Müller & Becker, 2013). Narratives are ubiquitous and hold the potential to indicate future changes in politics, economies and markets. As stressors and stabilizers in organizations, narratives and changes in the consensus narrative indicate the need for strategic change or organizational stasis and may be utilized as a source for early recognition in strategic management (Müller & Becker, 2013). Narratives of use are constructed in order to establish rhetorical use in speculative design. Speculative design normally is to design the object's context and the presentation of scenarios that give meaning to the object. The designer takes on the role of a storyteller and author where fictional scenarios are developed to position the object, but also where the imagined or rhetorical interaction with the object itself works to make the fictional scenarios believable. Narrative traditions are not only for remembering but are also a form of knowledge management. They can express elementary and tacit knowledge in tangible and emotional images in order to pass down this knowledge in a sustainable way (Zerwas 2013). Narratives of speculative design allow exploration of scenarios in aesthetics and allow us to use past knowledge to design for the future.

Narrative prototyping could be used in transformative design in different stages. This is a core (creative and aesthetic) skill from designers. This experience of using these tools will naturally use in the transformative design for everyday life and create different hero journeys with aesthetic experiences to

provoke the transformation happened. Narrative prototyping will makes use of aesthetic effects which are speaking to the emotional side of people; science-based messages address reason and can lack an aesthetic dimension and thus lack impact.

5.CONCLUSION

This paper is a very early trial to investigate the problems of design in the context of climate change. Problem-oriented design achieves high efficiency but can easily to lose the whole picture. This paper, based on some analysis, takes efforts to explore the new design philosophy that may be better able to deal with contemporary challenges.

These two design approaches are future-oriented for the long term and are characterized by the bigger vision that might break the limits of clichés. Also, these two design approaches are qualified by the very nature of social science and could relate to with the everyday life practice. In the meantime, these two design approaches complement each other in many respects. Transformative design does not emphasize the skills of a designer but speculative design take full use of skills like storytelling and prototyping, which designers are familiar with. So this paper concludes that the combination of these two designs is very possible to be a new design approach. That may be able to address the matter of transforming consumer lifestyles into something less destructive.

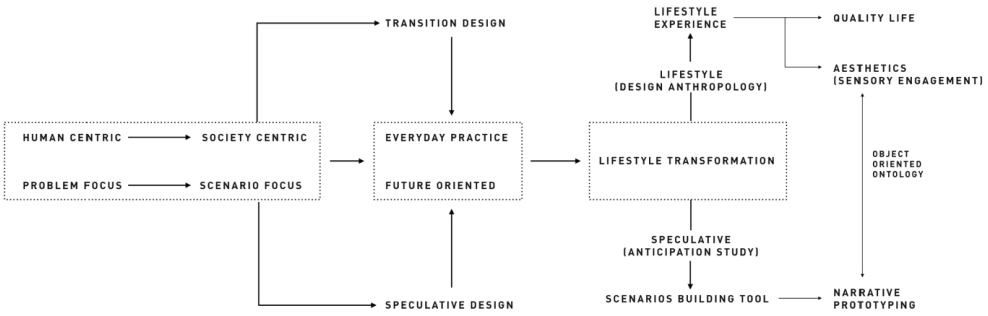
The new understanding of aesthetic experience like Object Oriented Ontology figures out the designer's strong role in transformative design for future lifestyles. Narrative prototyping with regard to the aesthetic experience not only makes people sense the future lifestyle, it also triggers an intention to transform their everyday life. In this way, creative and aesthetic skills from designers have a unique power to transform society in the context of climate change. This will be a step to transform the traditional approach to climate change.

From a practical perspective, lifestyle is still a complex system, and designers are challenged to find a way in which they can be a lifestyle transformer in the real world of "business as usual". More particularly this is a pressing concern when designers work with a commercial company, and they need a new frame to integrate this new knowledge. This paper shows the possibility that designers can use transformative design and speculative design methods together to design for lifestyle. In future, there could be more practices based on this knowledge in schools and governments to deal with the urgent issues of climate change. This paper opens a space to question the current design methods like the human-centric design and rethink the essence of design-, future, aesthetics and style.

DESIGN FOR QUALITY LIFE

Strategy of Paper Frame

SPECULATIVE TRANSFORMATION OF LIFESTYLE



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Sharpening anticipatory design senses for sustainable 'scentory' futures

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ABSTRACT

This article investigates speculative design and the olfactory concerning potential future life forms and styles for more long term sustainable and survivable futures. Referring to Anticipatory Design, the article links anticipatory speculative inquiry literature from design, culture and posthumanism. Included is mention of cultural historical and contemporary material on the olfactory and sensory related design. The article reaches beyond current consumerist market practices is cosmetics and perfume. It poses and projects alternative relations between the environment and bio-materials, the olfactory, embodiment, the sensory, and the perceptual.

These perspectives are related to leading olfactory projects and emerging trends and are embedded in a speculative olfactory project called *XIANGVEI*. Through a suite of speculative project artifacts, future life forms and life styles are seen having potential to contribute to wider systemic and collective systems of shaping futures knowledge by 'scentory' design. These life forms and styles are discussed in terms of in an eco-cultural-techno anticipatory design futures frame.

1. Framings

1.1. Design, anticipation, transformation and sustainable futures

Our human sense of smell is one of our most primal senses (Reinarz 2014). Smells move directly into our neurological systems and have an immediate, profound effect. Recently, received notions of the olfactory in humans as inferior to other mammals has been shown to be inaccurate (McGann 2017). This might seem like a boon for the commercial perfume industry that has expanded along with other life style aspects of global consumerist societies. However, in the contexts of climate change and the Anthropocene, the fragrance and beauty sectors, along with others such as fashion, are needing to reconsider and reconfigure many of their assumptions and practices concerning wider systemic issues of environmental and long-term sustainability. At the same time, our sense of smell is often not mentioned in expanding notions of embodied knowledge and being (Obrist et al., 2014); nor has it featured greatly in design research more broadly. Smell matters within wider human ecological systems and processes; the olfactory is sensory yet contextually, environmentally and culturally realized. This too has become apparent globally in the unfolding phenomena of the Covid-19 pandemic. The corona virus is invisible to the naked eye and is odourless while a significant indicator of infection is a loss of smell; long term loss of smell is also beginning to appear as permanent feature. The olfactory has also pervaded lifestyle sectors. Luxury

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perfumers have extended their brands to produce hand sanitizer. Face masks trap us into smelling our very own breath without which the medium of smell is absent (Ingold 2020). As we attempt to manage and halt the virus globally, it is clear that body, ecology, sense. technology and futures are inter-linked (see also Hsu 2020).

How might the future smell? In what ways might olfactory relations between nature and culture influence 'living futures'. These are some questions amongst others we have perhaps not often considered as a wider futures community. Let's pause briefly and sniff the wind of the present and future. How might we detect and project, trace and pose the role and materialisations of the olfactory in a wider posthuman environmental sensibility? (Braidotti 2013, Manzocco, 2019). How might smells shape us and how we might consider the olfactory as an affordance to thinking imaginatively together about long term, survivable eco-cultural-techno futures? In what ways might speculative design be enacted to conceptualise and mediate and offer some of these concerns?

Where increased attention has been directed towards matters of environment and product design and development in terms of sustainability (Walker 2006), long term change and survival have also been linked to de-growth (D'Alisa, et al., 2014). Rapid changes in the environment - weather patterns and species loss - are now cast in a longer ecological view (e.g. Latour, 2018; Morton, 2018) within which a new politics of design needs to be understood and to operate. Related nested systems and interconnected relational paradigms (Walsh et al. 2021) and practices need to acknowledge that design works and lives through its uptake in the biosphere, not only consumer markets. The global pandemic has also heightened awareness of the many challenges and contradictions in contemporary Design in the wider context of sustainability and notions and practices of futures (Fry, 2008; Fry, 2017; Candy & Potter, 2018; van Leemput, 2019). It accentuates earlier critique of design's often expedient adherence to market-driven profit, though much has been done in this century to reappoint design in terms of participation, e.g., social inclusion and co-creativity. For Dilnot (2017) needed is a shifting of knowledge perspectives from a mode of correspondence (Gergen, 2015) to ones of possibility, a turn that we present by focus on the "what-if?" in a mode of culturally located and anticipatory design-based inquiry (Morrison, 2017).

Design always seeks to reach beyond the given via creative, imaginary and situated making anew, and via the dynamics of shaping futures into potential and actual future experience and use in a mode of anticipation (Poli 2017a). As Kuzmanovic and Gaffney (2017) argue and demonstrate concerning postnormal times, and in keeping with the design-oriented arguments advanced by Dilnot (2017), we view anticipatory design as a trans-positional, co-creative, future- shaping pursuit and activity. We locate it in relation to life forms and life styles, beyond conventional perfume and cosmetics, that are designed to query understanding of relations between the eco-cultural-techno design and aspirations and potentials of sustainable transformation in the context of today's and tomorrow's climate emergency (Klein, 2015). In the wider context of 'smelling the future', our interest is also in in redirecting the olfactory to an anticipatory thinking with and through matters of sustainability for alternate futures. We do this by exploring relations within a posthumanist view (Forlano, 2017) that fashions and forges relations, not separations, between humans and nonhumans, techno-culture and nature.

1.2. Research focus, frames and methods

Below, we offer a humanities-inflected, qualitative and anticipatory design inquiry that is hermeneutic and reflexive (Julier & Munch, 2019). It assembles a transdisciplinary research review, a presentation of a mix of selected, qualitative and speculative design research methods, and a presentation and a discussion of specially fabricated speculative design artifacts. In doing so, we draw together aspects of anticipation studies with a focus on the imaginary, speculative and exploratory that is less about predominant approaches to foresight and centres more on connected design aspects in an approach of speculative prospect-*ing* (Lury et al., 2018). This concerns connected performative acts of both marking and mapping out 'claims' and casting forth, pitching, prompting and proposing a heuristic that works with a series of epistemic speculative design artifacts. The aspects of the project - speculative and exploratory, experimental and conjectural - are nested in the context of a future biosphere (e.g. Orr 2004) that also considers the histories of nature in design (Fallan 2019).

In order to lead our noses into the future, as it were, and then back to alternate presents (Auger 2013) and tomorrows, key conceptual and design propositions concerning life forms and life styles are posed and realized through a speculative olfactory design project called *XIANGVEI*. The name is a blend of two terms: XIANG in Mandarin connotes perfume, while VEI from Norwegian suggests a route. In Chinese, XIANG means good smell, and Wei means taste.

Chinese always puts these items together to describe things with a pleasant aroma and taste. If one changes the 'w' to 'v' the resulting 'Vei' means the way in Norwegian. XIANGVEI becomes a way of smelling to remind us to think about scent and futures in diverse cultural contexts. Similarly, XIANGVEI may be seen as also constituting a research way to think about futures differently through considering different cultures and their multisensory aspects as design materials. The *XIANGVEI* project includes four elements in the form of a "lab" and takes the shape of life-forms and life-style devices and engagements: an artifact, a wearable olfactory device, a related installation work and a manual to promote questions of use. *XIANGVEI* includes focus on the systems and relations of materials, human and nonhuman and the changing character of the global ecological systems as central to work on design and sustainability (Boehnert 2018) that is both urgent and underway.

2. Anticipatory design

2.1. Connecting futures and design

Since the 1960s two key domains of prospective inquiry - Futures Studies and Design – have emerged with core orientations. This may in part be due to a different early focus on strategic decision making and then systems orientation and plural futures on the part of

Futures Studies (e.g., Sardar 2013) and Design's shift from being a practical, solution seeking pursuit to becoming one of trans-disciplinary practice-based research positioned to develop and problematise potentials and emergent possibilities in interdisciplinary intersections (e.g., Marenko, 2018a, 2018b). In the past two decades Futures Studies and Design have expanded their concerns to a diversity of matters and have developed rich and interconnected research portfolios, methods and platforms so as to address matters of complexity, emergence, social and global needs and pressures.

Both Futures and Design have been concerned to investigate our conceptualisations, understanding and practices of futures but there remains work to be done to connect, transpose and differentiate their disciplinary and methodological concerns and specifics. The emerging transdisciplinary field of Anticipation (Poli, 2017a, 2017b) is one arena in which this has begun to appear to engage with anticipatory systems and cultures as 'taking care ahead of time' (Morrison, 2019). The related *International Conference on Anticipation Series*[1] has created a key arena for discussing and shaping futures in the light of global climate change, drives to more sustainable socio-economics, shifts in matters of policy and governance, and the dynamics of social engagement and creative co-constructions of survivable futures. The related view termed Anticipatory Design (Celi & Morrison, 2017; Morrison, Celi et al., 2021) approaches shaping futures through exploratory, critical and emergent anticipative practices that are culturally co- constructive, may be imaginary, disruptive and even unsettling in their heuristics of transformation in the context of the Anthropocene (Morrison et al., 2021).

In 'Towards an anticipatory view of design' Zamenopoulos & Alexiou (2007: 3-4) distinguished 'design from other conceptual categories or paradigms, such as problem solving (machine paradigm), exploration (evolutionary paradigm) or control (cybernetic paradigm).' Outlining relations and potential between futures and design, Celi and Morrison (2017: online) see design as embedding '… ontologies of future thinking in its artifacting and the materialization of artifacts while at the same time, and again and again, it works to engage in processes of knowledge generation through production in which participation and co-creativity are frequently central'. Zamenopoulos and Alexiou (2020) pursue a view on 'collective design anticipation' through engaging in the semantic and temporal in dynamics of space, boundaries, collaboration and power. Celi and Morrison (2017: online) provide an overarching outline of Anticipatory Design as follows:

> … Anticipation maybe shaped as a future pursuit, informed through Design and supported by way of linkages with Futures Studies that are equally polymorphous and conjectural alongside other much needed procedural, factive, and necessary foundations upon which to aspire, approximate, propel, and together project designs fictions and future-oriented inquiries.'

In their view, a future-facing focus on the cultural, communicative and speculative, as taken up here, may be understood as 'Anticipatory Design' (see also Morrison, Celi et al., 2021; Morrison et al., 2021).

2.2. Anticipatory design and the speculative

The anticipatory pragmatics of designing and ontological stance of speculating via designing have long been part of the cultural production of futures in literature, theatre, film, architecture, design and technology studies. We see Anticipatory Design as including cultural and speculative design elements in its wider constitution. Appadurai (2013) argues that we shape and appreciate the future as a cultural fact and that it is always mediated. He sees it as concerns as about working creatively with the material and immaterial. In doing so, we engage with given and changing cultural norms and related emergent practices, such as Afrofuturist views on the speculative, narrative and filmic (Jackson & Moody-Freeman 2011).

The imaginary and the speculative play a massive role in how we imagine, position, project and aspire to different futures (Markley, 2012; Rao et al., 2015). They allow us to speculate about alternatives and to bring them back to our current lifeworlds as means to rethink them and to think beyond them in developing actions from future thinking for the present. While such work may be known in some Futures and Cultural Studies circles, perhaps less known to them is the emergence of Speculative Design that has emerged within Design (Duggan, 2011). This label includes the early work on techno-artistic provocations and interventions in audience expectations, championed by the work of Dunne and Raby (2013) labelled "Critical Design" (Malpass 2015). Speculative designs serve as prompts, fictions and visions; they create imagined and perceptual artifacts and contexts of use. Speculative Design uses "context transfer", "hybridity", and "technocratic visualization" (Malpass, 2017) in working to de-familiarise, examine and encourage dialogue (Auger & Loizeau, 2013). It works to generate notions of new contexts of use and reconfiguration (Malpass, 2017). While critiqued for its conceptual focus and lack of attention to engaged use, the work of Speculative Design is imaginative and anticipative.

2.3. Anticipatory design, the sensory, affective and somatic

As with other areas of design and experience and affect, designing for scent works with emotions, memories, and behaviours and how these work between humans and the environment. In the past three decades, design related Human Computer Interaction (HCI) research has expanded its concern with systems and infrastructures to embodied interaction (Dourish 2001; McCarthy & Wright 2005). This has included the sensory and multimodal interactions, interfaces, experience and affect (Gregg & Seigworth 2010; Dourish & Bell 2014; Jones et al., 2016).

Such attention has concerned the ubiquitous (distributed, locative, wireless and mobile) together with multimodal interfaces and interactions (tangibility and touch, kinetics and proprioception, sensors and gestures). Increasingly, multisensory (Haverkamp 2012) affective and aesthetic qualities have been communicatively and creatively pursued. More recently this has extended to the somatics of

[1] http://anticipationconference.org/series/.

linked (not separated) body-mind relations and how emotions and signals are felt, sensed and experienced (Loke & Schiphorst 2018).

Sensory design has been taken up in wearables in HCI as well as in architecture (Malnar & Vodvarka 2004) concerning perception and experience of place and space. Humans engage multi-sensorially in such environments as atmospheres for emphatic imagination that are realised in modes of affective experience and by way of ambient sensation (Pallasmaa 2014). Such sensory inquiry has begun to extend to the olfactory within research in design (Lupton & Lipps 2018). While such developments in embodied computational interaction explore the potential of design to develop alternate futures, they have been widely critiqued for underlying techno determinist premises located in political economies of growth at the cost of the environment. The next section prefigures later discussion of this matter via speculative olfactory Anticipatory Design by surveying relations between smell, ecology and culture.

3. On the olfactory, ecology & culture

3.1. Orientations to cultures of scent

The olfactory, the oldest sensory system, has privileged, direct access to the part of the human brain that influences affect and emotion (Herz 2007). Clinical studies have shown that anosmia, the loss of one's sense of smell, can cause depression; depression can also lead to loss of smell. Scent is also one of the oldest human cultural and behavioural modes of expression (Drobnick, 2006; Jenner 2011; Jones, 2011a, 2011b). It has been used to provide signals of seasons and the environment, functioned as a sensory and cultural material, and featured widely in the realms of religion, life styles, and sensuality (Reinarz, 2014). Smell has a strong influence on our emotional and sensory lives yet is seen to be the most underestimated sense in modern western cultures (Classen et al. 1994) and lowest of the senses in a western enlightenment view (Gilbert 2015).

The term aroma is derived from religion, both in the West and East. Perfume was embraced ritually to help create a space to talk to God. In the East, scent culture was expressed by the literati, a symbol of knowledge, and the creation of a spiritual world transcending the material world. Extracted and worn perfume is an integral part of cultures of scent and the evolution of scent cultures (Classen et al. 1994). Perfume has been extensively developed by Middle Eastern societies and has influenced its western uses as adornment and sensuality (Abram, 1997). Smell has further been used to understand the environment via a 'calendar of scents'. Aboriginal peoples of the Andaman Islands used smell to understand and shape the patterns and uses of time (Classen et al. 1994). Different languages also express smell differently (Majid & Burenhult 2014) while enthographies of smell also indicate that smell is gendered and culturally framed, not only in western formulations (Moeran 2005).

Perfume has functioned in diverse areas such as medicine, identity, religious activity, and rituals of everyday life (Chen, 2017). In 16th century aristocratic France, perfume was used as personal decoration and to mask undesirable odours (Corbin 1986). After the First World War, influenced by the clean movement, the preference was for scent-free clean spaces. Later, as with the globalization of the fashion industry, fragrance and cosmetics have become symbols of consumerism and life styles. Today the perfume industry is linked to personal identity and related gifting. It is also central to domestic and commercial cleaning products, with its reach extending to marketing and the military (Drobnick 2018; Schmeisser et al. 2013). Specially crafted olfactory prompts to consumption and safety connote different styles of living and working (Cain et al. 1998) as well as to cultural histories of smell (Brant 2004; Corbin 1986; Dawson 1998; Drobnick 2012; Stamelman 2006). Attempts to provide mediated public popular cultural experiences of smell appeared in initiatives such as 'Smell-O-Vision' connecting the olfactory and film in cinemas (Brownlee 2006). As part of digital culture, smell has been incorporated into the content and interfaces, memory making and place identification in 'sensory maps' that connect cartography and context through public smell walks (McLean 2016); 'Scentee' is a suite of interfaces for adding the olfactory to situated experiences, especially ones mediated via mobile devices (Harris 2013).

In recent years, the consumer centred character of the global perfume and cosmetics sector has come under critical scrutiny and has begun to be re-oriented towards ecological and sustainable design, including digital culture, space and art (Brant 2008; Hsu 2019). This is in contrast to the predominant features of this industry with massive waste of packaging, practices of animal testing, and unfair trade in plants. In contrast to the marketing and appreciation of wine, seldom is information provide on the history or ingredients of perfume, and even less on its ecological footprints. A trend is emerging for bio-friendly products and organic materials and shifts in directing consumer preferences. Alongside this, an anti-fragrance movement has emerged, together with wider marketing of gender-neutral lines and the presentation of the sensual and aromatic as a feature of 'natural' products. As with other life style domains, such as food and fashion, cosmetic companies are repositioning themselves through marketing their concern for the environment, aesthetics and affect. Guerlain's 'The Black Orchid', for example, promotes luxury ecological and design stewardship of the revival of Peruvian Andes species with traditions of Japanese porcelain.[2]

Technologies have been central to the development of our olfactory products and experiences. Futurists have predicted that our sense of smell may be desensitised and that the human nose will change its physical structure, becoming smaller, and lose its functions (Gilbert 2015). Already in today's perfume industry 'e-noses' are being applied to identify ingredients via a set of chemical detectors used in medicine to detect disease states, ranging from tuberculosis to breast cancer.

Such a tool may be deployed in security and safety settings to detect banned materials, toxins, or chemical weapons (Herz 2007). At the same time, perfume from the moon and space is also now digitally marketed.[3]

Recent developments in the sector are led by design innovation and ecologically responsible future olfactory initiatives. The Korean

[2] https://www.lofficielarabia.com/beauty/orchidee-imperiale-black-cream-guerlain-paris.

[3] https://eaudespace.com/.

company GENTLE MONSTER has developed ways to 'carry' scents[4] in a market where art and storytelling are central to the cosmetics sector.[5] In 2021, perfume as social intermediary for the benefit of people and planet, framed as olfactory design, was launched in a collaboration between the leading perfume company Firmenich and design school Central St Martins in the U.K. Online mediation[6] includes a set of key future olfactory frames, including trends, positioning, and four 'olfactive' paths (Shift the Rules, Playful Reconnection, Post Crisis Luxury, and Greater Good).

Given these developments and research into changing relations between the olfactory, ecological, technological and cultural especially in the past five years (e.g., Lai and Cao 2019; Obrist et al. 2016), we coin the term 'scentables'. The term aligns with research that argues for 'bringing the body into futures work' (Bussey 2014; Bussey 2017). Research into olfactory perception (Wilson & Stevenson 2006; Zarzo, 2008; Rindisbacher 2015) is appearing with acknowledgement of related cultural (Shepard 2004) and medicinal (Palmer 1993) contexts and uses and professional historiographies (Kettler 2017). However, little research covers how the olfactory is being repositioned in life styles in which 'scentables' may be realised through relational configurations of the ecological, technical and cultural. Recently, in the context of decolonising the deodorizng of the olfacotry and shaping connection betweeen olfaction and enviornmental risk, Hsu (2020: 201) argues for an extended framing of 'olfactory modes of knowing and ecological relation…' as visceral but also as a device for the further aesthetic unpacking of local cultural geographies of smell. Concerning this 'atmospheric', Hsu (2020: 7-8) suggests that:

> … scholarship in materialist ecocriticism – formed by recent research on olfaction in the fields of sensory studies and environmental history – can help us better understand how aesthetic projects have variously sustained, contested, and presented alternatives to differential deodorization.

3.2. *Life forms and life styles*

In our sustainability and speculative design view, the olfactory is a major if under articulated aspect in daily living and related lifestyles that are undergoing changes in the context of climate change and an emerging circular economy. Our human commitment to long term sustainable futures in part depends on transformations of our lifestyles and acknowledgement of connections not separations between the human and the environmental as a central part of survivable and ecologically responsible futures (Opperman, 2018).

The term life form refers to an entity that exists or is thriving. The conditions and forms of life that we may encounter and imagine are changing due to the development of technology, human biological abilities, and improved social conditions. That life forms are radically changing is significant in a futures design view when our concern is to reach forwards to possible and imaginative offerings of ways to understand and appreciate ecological and environmental contexts. Three views matter here that may connected to post-humanism and speculative inquiry and design.

First, the form of human beings has changed in the context of digital and bio-engineered augmentation. In the field of trans-humanism, scholars have begun to imagine what forms and agency objects and humans of the future may take (Marenko 2014). Posthumanism hopes that human beings may be free from physiological limitations through human enhancement (Ranisch & Sorgner, 2014; Ferrando, 2019). In this study we suggest how posthumanist views may be appointed to an ecological speculative design project to ecologically enhance connections between human and non-human participants and systems. Second, the diversity of non-human entities is decreasing. The *Living Planet Report* (Grooten & Almond 2018) details that annual species are lost and environments are degraded and denuded. Third, with the rapid development of Artificial Intelligence, human-made things have many features increasingly linked to humans in the Internet of Things and via bio-tech engineering, thus expanding the scope of life forms.

As a whole, current relationships between different life forms may arguably contribute to the collapse of the wider ecosystem. Faced with this situation, post-humanism is actively looking for ways to free humans from an ecological model under threat of destruction. The core of the theory is that we need to adopt a non-human-centred view. Haraway argues that human beings are not creating history by themselves in the Anthropocene (Haraway 2016). Instead, she argues, humans and nature are making history together. Gagliano et al. (2017) point out that plants have their own signalling 'language', supporting the assertion that life forms be treated equally. Deep biology describes the relationship between humans and nonhuman, while the 'Deep Ecology' approach calls for a redesign of human-made systems to preserve the ecological and cultural diversity of natural systems (Næss et al. 2010). While design needs to embrace humans and nonhumans in its futures, to some degree these will be futures still related to human life styles.

Broadly, life styles may be used to refer to a holistic view of the character and choices that make up everyday life (Giddens 1990; Jensen 2007). In this quotidien, structural intersections of symbolic relations and productions of access to products, and later interactions and services, have come to be understood as entanglements of identity and consumption (Featherstone 1987; Johansson 1994; Sobel 2013). This has been manifested in life style studies on subcultures, identities, youth, leisure and tourism studies, amongst others. Life styles seen as affective and performative demarcate and construct emergent social and cultural boundaries and expectations; these have been materialized historically, symbolically and expressively (Holt 1997). Spinosa et al. (1999) argue that lifestyle may be investigated by coordinating actions of daily life, the value between things and people, and new situations compared with past ones.

More recently, notions and practices of life styles have been taken up with regard to the growth of social movements (Haenfler et al.

[4] https://hypebeast.com/2021/1/tamburins-the-shell-perfume-hand-cream-release-info.
[5] https://www.tamburins.com/.
[6] https://regeneration.firmenich.com/olfactive-design/.

2012), locative and social media and urban living. Life styles have also been connected to environmentalism and emerging practice and discourses around changing consumer behaviour and consumption in the context of climate change (Klein 2002), such as in recycling in post-growth fashion (Fletcher 2016). Calls for a change in the ways of living have also been articulated in approaches to alternate lifestyles such as in the ecosophy of Næss (1990) and in connecting design and nature (e.g. Fletcher et al. 2020), though not often as futures or anticipatory life styles.

Recent work on 'cultures of sustainability' (Meireis & Rippl 2019: 250) encompasses differing world views for supporting and creating sustainability and this extends to reconceptualising life styles relationally in the wider contexts of the Anthropocene. The linked notion of 'sustainability of culture' refers to the dynamic arenas and practices of discourses for ecological and environmental survival. Sustainability-culture relations may be understood, we suggest, in terms of connecting the ecological, cultural and technical. A precursor to this is *The Three Ecologies* in which Guattari (2000/1989) presents a tripartite 'ecospophy' comprised of the social, mental and environmental. These ecologies are relational and come into being through their selection and intersection of vectors in a critique of the seductive, motivated efficiencies of capitalist production and consumption. Transverals - across and between these three ecologies - are central to Guattari's 'ecosophical' framing. Similarly, we locate the sustainability of culture in transverals across and between elements of prospective, exploratory speculative design. We see these as these moves through which relations between the imaginary and prospective and the human and nonhuman are key aspects to prompting and suggesting possible transitions and thinking into future eco-cultural-techno life styles (Garduno García & Idil Gaziulusoy, 2021).

4. Speculative design approaches, practices & works

4.1. On speculative design

In a little over the past two decades, Speculative Design has emerged as a dynamic, edgy and exploratory design knowledge domain and has also included works on the olfactory (see below). Auger and Loizeau (2013: online), leading proponents of Speculative Design, note that:

> Speculative design combines informed, hypothetical extrapolations of an emerging technology's development with a deep consideration of the cultural landscape into which it might be deployed, to speculate on future products, systems and services. Hunt (2019) reminds us that 'Designing to solve complex systems is impossible. But that doesn't mean we shouldn't strive to model heuristically their tendencies, potentialities, and misbehaviors.' (Hunt, 2019: 127).

The heuristic nature of Speculative Design is central to how it is perceived and received as a mode of conceptualising and not solving, despite concerns on the propositional and potentially privileged character of its designerly focus (Martins & Oliviera, 2014).

Ontologically, Speculative Design poses potentials, possibilities and problematics. It does not seek to solve, determine or confirm a set of empirical propositions, but rather to conjure by abductive, poetic and reflexive means evocative options, alternative, prospects and projections of possible futures and alternate presents. These are futures that are about versions less verifiability, they are plural, diverse and emergent (Escobar 2018; Sardar 2013). They are devices, artifacts, enactments and venues that are performative, expressive articulations offered for discussion and debate, not conformation but conjecture on the critically communicative sense. Importantly they have the speculative as a material and means in mediations that work with modes of becoming not only being (Marenko 2018b, e.g. Whitehead 1938). This is a matter of engaging in mode of speculation and conjecture, in a what-if of innovations between boundaries, hybrids, expectations, mediations and experiences. Attending to the olfactory in a subjunctive and non-consumerist mode may accentuate relations between the sensory and the environmental, as well as cultural practices and embodied affect.

Dunne and Raby (2013) initially sought to investigate future technologies in a non-commercial perspective through design prototypes in a Critical Design, through product related view (Malpass, 2017). This has been extended to include other domains of design and speculations, such as the role of poetics, personas, scenarios and world building in design fiction (Blythe et al. 2016; Celi & Formia 2015; Coulton et al. 2017; Hales 2013; Markussen & Knutz 2013; Morrison 2014; Morrison & Chisin 2017). The media, art and design studio functions as a site and a process for exploratory, speculative inquiry and the shaping of cultural artifacts that invests in inventive research methods (Lury & Wakeford 2012), including ones devised and informed by design. As Farías and Wilkie (2016: Kindle) note, the studio is '… a space that harbours and manifests the conditions in which prototypes, models, designs, media and visualizations are conceived, planned, tested, and synthesized into coherent, bounded and affective forms.' The studio, such as shown in the examples below, allows us to cross, blend and diffract, amongst other creative and analytical acts, processes, materials, means and acts of critical and reflexive making and research. Its outcomes may be understood as devices and acts of devising (e.g. Avila, 2012), and the means of designing what might be possible through a diversity of tools and technologies, articulations and forms. These may adopt the status of prototypes and prospective heuristic artifacts that in an anticipatory design sense (Miller, 2018) reach beyond probable futures to imaginary ones. The work they do may be evocative or provocative, associative or abductive, and it is often characterised by being putative, conjectural, absurd or disjunctive.

Speculative Design may be positioned and circulated differently when its disciplinary partners and communicative destination are not scientific outputs but mediational, cultural and poetic ones. When positioned in a Futures Design frame, speculative design mediational artifacts may indeed create a sense of unease, surprise or disruption. This is the work they may do that is connected to other differently located critiques from the social sciences and technology studies. Nor is this to reify artistic research as a mode of inquiry that refuses critical reflexive accounts of making and knowing. Critique may be applied within STS, techno-science, digital art and participatory design alike. However, these may be drawn together productively in new, dynamic and emergent ventures through

speculative inquiry (Lury & Wakeford 2012; Wilkie et al., 2017; Wilkie, 2018), as a creative, collective and transdisciplinary endeavour that demands new habits and practices of attention, invention, and experimentation, including aesthetics and lifestyles.

4.2. Selected speculative works on the olfactory

In the past decade, the olfactory has appeared in a number of prominent experimental collaborations between researchers and artists. Several of these with a futures view are presented below to provide context for the Anticipatory Design speculative work *XIANGVEI*. The exhibition publication *Sense of Smell* (van Brakel et al., 2014) gathers together a medley of seven olfactory based interactive installations through the construct of an *AVANT GARDEN*. With the shared aim of exploring the blurring of the physical and digital and biological, the works asked 'What does future thinking perfumery smell, sound, feel and look like?' In *An Alphabet for the Nose* Sissel Tolaas (2011) presents her work into developing a vocabulary of smell she calls NASALO. Tolaas (2011: online) claims that we need to develop tolerance toward our surroundings and that 'If people get the message through the nose, they really get the message'. Such a view was central to the transdisciplinary symposium *Headspace: On Scent as Design* (2010)[7] that included formal specialists and participants in exploring scent as a new territory for design, such as elaborated in the exhibition *The Art of Scent 1889–2012* (Burr 2012) and appearing in related publications on the emergence of olfactory art (e.g. Shiner 2020).

We now turn to two leading projects that exemplify how a wider ecologically framed speculative design approach may pose, propose and project materialities, problematics and thinking about possible, potential and putative 'scentory' futures. In their speculative work called *Smell +*, Auger and Loizeau (2009)[8] devised a 'blind date' scenario to accentuate the neglected sensory qualities and properties of the olfactory in human communication from and to the body This non-literal piece schematises the embodied production of smell from human bodily secretions.[9] The 'smell suit' they developed (Fig. 1) has closed pouches that channel pheromones from the body's specific apocrine or scent glands to the chest, thereby reducing exposure to oxidation and the production of bad odours. As a prototype, phase, the suit allows the wearer to become more aware of their sense of smell and their worn smell; the suit is also intended, as a speculative piece, to indicate how we may reactivate our olfactory sensibilities in attraction and attractiveness to others.

Resurrecting the Sublime is a transdisciplinary project (2019) from Alexandra Daisy Ginsberg and artist Sissel Tolaas collaborating with the biotechnology company Ginkgo Bioworks (Fig. 2).[10] This group revived selected flowers which have disappeared and become extinct because of earlier colonial consumption of the plant's fruit. The bio-synthetically revived flowers were designed as part of an installation to allow audiences to smell extinct fragrances. This project is an example of how designers took up prototypes in an interdisciplinary approach to explore the workings of what may be termed eco-visioning. This creative act of revival points to one way of alerting publics to the importance of species protection and the olfactory value of nature in opposition to potential and continued biological collapse in the future.

4.3. The XIANGVEI project: connecting elements

As an exploratory speculative design research project, *XIANGVEI* proposes a rethinking of the commercial perfume industry. The related XIANGVEI 'lab' and linked services pose ways of communicating olfactory and posthuman futures between humans and nature rather consumption models of the cosmetics industry. *XIANGVEI* is composed of four connected parts: 1) an olfactory design artifact, 2) a wearable scentory work, 3) an experiential installation, and 4) an advert for cosmetic surgical olfactory enhancement. The suite of works serves to prompt a set of questions as motivations for engaged discussion focused on fragrance to engage and challenge us to think about the olfactory and the ecological through the olfactory.

Research embedded in the works operates laterally across different areas of scent, culture and technology, and forms and styles of perfume. The experiments serve to disrupt, reinvigorate and re-direct how we might deploy scent, smell, and the scentorial in understanding relations between human and nature in changing climates for futures inquiry and future climate change in the Anthropocene (Morrison, 2018). While these works do different things, they draw on design expertise and research into product, interaction, service and systems design, proposing alternates to current consumerism. They acknowledge we live, work, create, consume, buy and sell things in a world that will continue to be revised and altered in a wider posthuman ethos.

The XIANGVEI project has been the speculative design concern of the first author, as a designer and researcher. In terms of methods, he conceptualised and implemented the works from ideation to product production and through to research review, with the second author in an advisory and co-research role. While the artifacts are speculative in nature, they have been designed and exist in physical form, including processes of co-design, revision and practical suggestions and interventions from specialist design producers in Shenzen in China, in conjunction with the first author. The works have also been presented in several research and educational settings from which discussions and critiques have taken up in a wider reflexive designing and reviewing process (Lury et al. 2018).

[7] www.headspace2010.com/index.html.

[8] http://www.auger-loizeau.com/projects/smell.

[9] These sites of olfactory essence are taken up in murder narratives around their procurement in the novel (Suskind, 1986) and film *Perfume* (Tykwer, 2007) and in the recent German series *Parfum* (Kranenburg et al., 2018) on Netflix. These works play on the trope of the 18th century French perfumer Jean-Baptiste Grenouille renowned for his excision of human apocrine glands in pursuit of irresistible attraction.

[10] https://www.resurrectingthesublime.com/about.

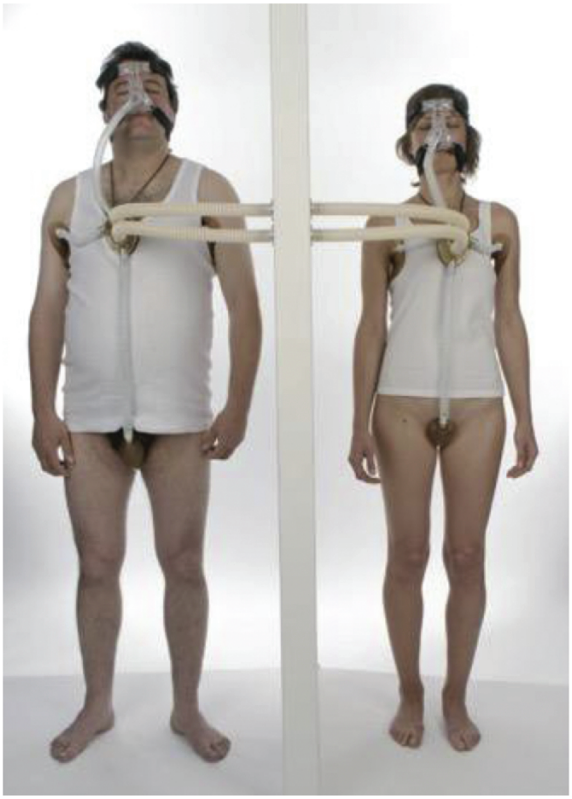

Fig. 1. *Smell +*. Smell suit. (Auger & Loizeau, 2009). (Used with permission).

5. Speculative design expressions and *XIANGVEI*

5.1. *Grown Perfumer: As an artifact*

In an era of consumerism, we also live in an anthropocentric world. We eat processed foods; we do not know their origin. We may use perfumes named four seasons, but we cannot often recall the subtle changes of the four seasons in dense cities with poor air quality. In contrast, *Grown Perfumer* is a wearbable, eco-speculative, olfactory device that helps humans find new ways to live with nature as a shaping a culture of ecological access to a "plant language" through the design medium of smell. As the name suggests, it has been conceptualised and designed, prototyped and trialled to help us imagine and embody ways the scentory may be expanded as part of connecting persons, natural substances and product development.

As an imagined artifact, *Grown Perfumer* consists of three main physical elements derived in part from the technologies of perfume making (an oil distiller, a recognition system, and silicone tissue; Reinarz 2014; see Fig. 3). The silicone tissue connects the human body and other parts of *Grown Perfumer*. Silicon-based tissue can have biological characteristics. It is seen here (right) to transmit biological signals into the human nervous system. There is an elastic breach on the silicone tissue. A person can place different flowers and plants into it and also clean it.

The oil distiller is the primary functional part consisting of a condenser, an oil drainage tube and an oil container. The oil distiller uses energy from the human body through the silicone tissue so as activate perfume. The oil container is made of bio-film. Oil produced by *Grown Perfumer* can slowly evaporate through the bio-film.

A related recognition system consists of a probe and a chip. The probe can recognize the radio and scent signal of the plants inside *Grown Perfumer*. Nansen (2017) argued that radio signals from plants are a kind of bio-language. In this situation, the chip can understand the language of the plants through calculation and transfer the information into human nervous system signals.

In the wider biosphere, scientists can judge the health of the ecosystem through studying a plant; they understand a plant's physiology and the operating interactional mechanisms and of a wider ecology. The plant world may seem simple, but research into its communicative character reveals that plants have complex signals and networked ecological systems of growth, communication, adaptation and resilience. While we try to communicate with aliens in deep space, we may forget to "read" plants and to examine ways

Fig. 2. *Resurrecting the Sublime* (Ginsberg & Tolaas, 2019). (Used with permission).

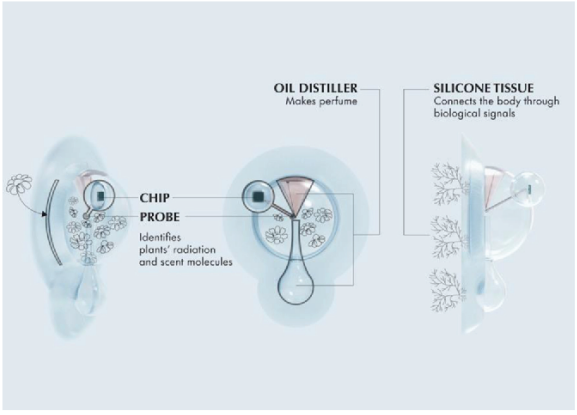

Fig. 3. Structure of *Grown Perfumer* (Zou, 2021).

to communicate with plants that accompany us day and night. Where signals and scents are emitted by leaves and flowers, as shown in Fig. 3, technology may be developed further to allow us to better understand more about communication between plants and humans.

5.2. *Grown Perfumer: As a wearable*

The structure of *Grown Perfumer* enables it to become a sustainable wearable 'scentory' artifact in three ways. First, for a human to produce perfume through wearing the device, they need to learn about the different plants around them and to try to mix different plants to create their own fragrance instead of buying a commercial perfume. This is a new experience for humans to come to appreciate, know and explore the environment around them.

Second, the cognition system of *Grown Perfumer* provides a unique experience of scent. Signals from plants can be transferred to a language that the human nervous system can understand synaesthetically, that is as a feeling of the temperature of plant's growth environment. This may be seen as a new ability to communicate with plants and, in turn, it may also function as a route to further, sensory, and scentory appreciation of the environment.

Third, *Grown Perfumer* can collect connected data through the plant's signals in the mode of a map of the environment conditions and the device beyond an individual's typical purchased consumption of perfume. Consequently, a human being can increase cognitive awareness of smell, plant life and environments through this system. These experiences too may then be shared.

As a design, communicative and sensory mediating artifact, *Grown Perfumer* functions as a new conceptual wearable that extends the application of perfume to skins to its embodied production (Fig. 4). It also links scent to a new conscious experience based on future computation. Where embodied interaction typically talks about conscious experience and the relationship between social setting and technology, *Grown Perfumer Wearable* is a device integrated with a different mode of advanced "enviro-wearable" technology. It proffers a new scenario of future wearables so that the mode of "future perfume" it materialises may itself become part of scent culture and may be transferred into new interactions with nature.

5.3. *Grown Perfumer: As an experiential installation*

In keeping with this direction towards the olfactory, human and environmental links, experience and awareness, an experiential installation was set up to see how to connect the devices to wider contexts of experiential use and ecological implications. The installation is widely used in speculative art and design projects to provide fuller setting and means of access and use than for single artifacts and allows connections, in this case, the context of ecology, mediation/sensory and technical systems and experiential use. We were also keen to see how a small groups of users engaged only in a level of conceptual design use might respond to the device and its wider issues of context. The design installation is composed of three parts: the design organ, a plant video, and a mirror (Fig. 5).

A scent diffuser is central to the installation into which selected flowers or leaves are placed. When worn, it activates a gravity sensor that turns on the aroma diffuser and video. When people wear the artifact *Grown Perfumer*, 1) both video and scent emerge. People see themselves with the object in 2) the mirror and also see a 3) video of the flowers or leaves. They can also 4) smell the scent of the natural plant elements via a diffuser.

A viewer has the following experience: when one wears the design organ with its botanical aroma, a video of the plant's biological setting is played. It offers an extended experience of the olfactory, the material of the plant, a sense of embodied experience, and several visualised contexts of the plant's habitat. Playing on the familiarity of tablet type screens and wearables in our 21st century lifeworlds and life styles, the installation projects the experience of smell into contexts of its remote environmental bio-origins.

To achieve this, a mirror is situated in front of the video, and a participant or audience sees a mixed image (themselves and the plant). This blended picture indirectly allows a viewer to sense an integration of a new organ and plant consciousness. One may see their new organ in the mirror, with the image embedded or framed in the plant's ecological setting. This fusion of one's impressions and smells, and the presence of the video, provide a multi-dimensional experience of sensing and a feeling of a different scentory future.

While the installation is a mock-up of the experience of *Grown Perfumer*, the tangible experience of self, device, scent and images enables a participant to think of the meaning of the larger scentory concept beyond the installation. The installation was trialled with small groups of 15 users to ensure its processes were easily understood. The series and layers of effects and experiences noted above were ones they reported on finding, sensing and appreciating as intended.

5.4. *Grown Perfumer: As invitation to bodily enhancement*

In terms of life styles, cosmetic plastic surgery has been discussed in terms of its gender and cultural conformism and values

Fig. 4. Design for *Grown Perfumer Wearable* (Zou, 2021).

Fig. 5. Structure and use of the *Grown Perfumer Installation* (Zou, 2021).

reproduction (Heyes & Jones, 2016). It has become a prevalent in affluent circles, such as in cosmetic surgery tourism (Jones, 2011a, 2011b). In South Korea, cosmetic surgery has become a widely subscribed service, with procedures increasingly for younger consumers (e.g. Stone, 2013). Behind this trend is the notion that when humans change the structure of their bodies, their bodies may be strengthened functionally and aesthetically, leading to enhanced attractiveness and advantage in job procurement. However, the related purchase of 'face types' circulated on social media and by cosmetic surgery firms is a troubling shift to a homogenisation of notions of beauty and the erasure of specifically Asian defining features in favour of western assimilation.

In contrast to these appearance-driven trends, the *XIANGVEI* project includes a quirky cosmetic surgical olfactory enhancement product called *Grown Perfumer Bodily Enhancement*. This product was crafted as part of an extended notion of the speculative relations

between wearer as performer and wider eco-cosmetics. The point of this ironic device is to cross the posthuman and prosthetic as an evocation of an alternate notion and potential practice of biological bodily enhancement.

A speculative scenario called *Grown Perfumer Bodily Enhancement* was developed that included a *Letter of Consent* for bodily augmentation with the *Grown Perfumer* device. This 'application' for a life form and life style bodily modification indicates a change in value between human and non-human (Fig. 6). In contrast to the pervasive spread of a 'corrective cosmetics', the service here may be viewed almost as a type of responsible environmental social action. The transition in the value and actions of interactions between people and perfume is an expression of potential future life styles where bio-sensory human/non-human relations are embedded and embodied, worn and experienced.

Where the installation part of the project may be said to be distanced from the immediate corporal and felt body, this part of the project seeks to connect the sensory, embodied, designed artifact and the transubstantiation of bio-eco products and materials through the literal embedding of the artifact into human flesh, nerve and bone. In this way, the body is connected to the materiality and the olfactory. The bodily enhancement is thus not one of aligning one's nose, or removing 'double eyelid' features, but one of contractually marking out that cosmetics, including perfume, are themselves under transformation. Enhancement may thus be seen and felt as sensory and scentory. Bodily modification is projected as being extended to bodily-environmental modification. This situates the olfactory, the surgical and the bio-environmental in a mode of cultural and consumer life styling as acts of posthuman change and perhaps uncomfortable, as-yet-to-be experienced identify formation. This speculative document, application and prospective procedure function as an epistemic artifact, challenging us to think with and through the olfactory into the 'artificial' but also beyond it back to our human-nonhuman participation in speculatively shaping futures through Anticipatory Design for alternate presents.

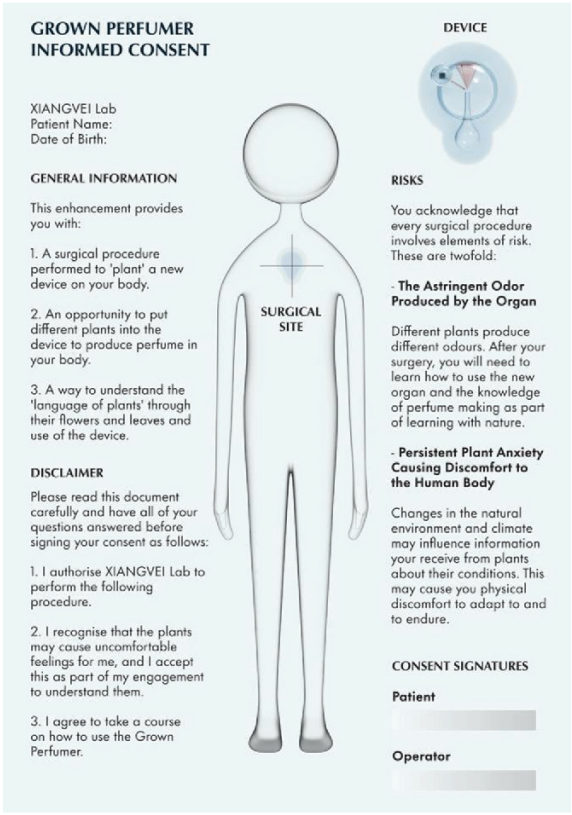

Fig. 6. Letter of Consent for *Grown Perfumer Bodily Enhancement* (Zou, 2021).

6. Discussion

6.1. An ecology of anticipatory speculative design for sustainability

The *XIANGVEI* speculative experiments provide tentative and prospective aspects on how we might think into and through an anticipatory shaping of what we term "an ecology of speculative design for sustainability". The first key question we addressed was on ways smell may be connected to a heightened sensitivity to the biological, the environmental and the planetary. As we have shown, to some degree the indirect reach of such a project is towards raising awareness and priming interest in understanding relations between olfactory elements, processes of scenting and contextualising sensory and environmental sensitivity. Earlier we referred to Ecological Psychology and its view that a meaningful environment constituted by its tools and artifacts and representations are fundamental to processes of cultural evolution (Heft 2001). In our work we augment this view with a speculative experiential turn to the environmental that includes attention to not only the scentory but also the cultural. This is a matter of connecting artifact and mediation via experiential scentory speculative scenarios with designed physical products and the implications they may convey, propose or propel. *XIANGVEI* as a whole becomes part of a wider human organ that produces perfume. In the context of climate change, the tool is part of the body. Yet it is a tool for questioning our sensory awareness and perceptions of smell in the context of environmental challenge, change, adaptation and survival.

As shown already by fashion's uptake of re-use, DIY and degrowth practices as well as the spread of organic cosmetics, shifts are emerging in personal, niche and wider commercial interest and practices connected to more ecological practices and potential future models for the sector. In the fashion sector, there is potential for the sharing of knowledge and experience and environmental material sensory and 'scentory' expertise to be reoriented and repositioned in wider shifts to changing ecologically and posthuman inflected values and life styles that may extend beyond bottled mass-produced perfume brands.

6.2. Life forms, life styles and speculative design futures

Some of the potential implications of the integrated and speculative design character of the *XIANGVEI* project may be discussed in terms of: 1) life forms, 2) life styles, and 3) envisioning events.

1) Life forms: In future speculative design processes, we may find that we are forced to more fully consider life forms due to the further development of technologies and the growing presence of AI, robotics and augmented corporeality in the content of posthumanism. As an 'organ', *Grown Perfumer* is not an original product design concept geared towards functional markets. The concepts and values it embodies point not to a trend towards centralization in a digital age, but that we need to understand human enhancement as a decentralized process. Designers will likely work within wider, distributed and connected design arenas in the future, from distant space to the interior of the body, from humans to non-humans.
2) Life styles: Different life styles are indicative of various actions and values generated by the interactions among humans, artifacts, and environments, including nonhuman. As an alternative plastic surgery service, *XIANGVEI* lab offers aspects of a possible pseudo-realist alternate life style. This is connected to current investigations and emerging practices concerning posthumanism. In the imaginary service portrayed, life style matters concern the value of mutual care between humans and plants, and new subjunctive actions of fragrance culture as 'plastic' surgery.

While one may be critical of uncritical future scenarios, the pressures of the immediate material world make it difficult to imagine an elegant poetic life imbued with hope and love. Through the medium of smell, focus on the fragrant, ambient and natural environments of flaura and fauna is coupled with the given warmth and 'wearablility' of the human body. This merging of sense, experience, material and environment allows us to at least imagine future scenarios positively.

Designers and olfactory design sectors, not only the commercial perfume industry, could use prompts such as this one offered to work with styles and different designs to further reflexively and radically explore values and actions generated by the interaction between surroundings and humans. Imagined aspects of life styles may thus be conceptualised as themselves being radically re-oriented and investigated via speculative design inquiry where smell is an unexpected, transformative material medium in its own right, but in connection to systemic and other modalities of co-creative shaping survivable futures.

3) Envisioning events: This shift or reconfiguration and radical sensorial unpacking of sustainability via smell as opposed to visual senses, suggests ways in which a situated experiential speculative view on futures allows us to appreciate the ecological and think through such anticipatory design activity into sustainability contexts and potentials. Envisioning events in this way provides a creative arena for the perfume industry to radically and anticipatorily re- imagine alternative strategies for scent and smell around a number of questions. What role might local perfume play in the future? Could perfume become a kind of knowledge medium for people to better understand our environment? What kinds of scentory products might serve both people and nature in local contexts?

This may be extended to projecting different ecological futures as sensorial, survivable, sustainable designs. Scent may also be transformed into emotions through association and then connected as affective and anticipatory sensory design prompts, influencing how we feel, think and act. Here there is potential for the scentory to be extended beyond the traditional perfumery or cosmetics counter to wider embodied experiences of wearing and sensing plants, flowers and experiences.

7. Towards scentory anticipatory design futures

We have argued that an Anticipatory Design approach to working with the speculative and the olfactory offers ways to pursue and promote attention to the sensory through and for smelly futures that may be diverse, emergent and importantly build our sense of relations between the olfactory, environmental, ecological, technical, social and cultural. As we move to more carbon neutral living and working environments, might our artifacts and our relations to them also 'smell' differently? By way of a transdisciplinary review of research and projects and a speculative design suite of works, we have suggested that the olfactory may be more fully taken up in conceptualizing the imaginary as part of wider Anticipatory Design in sustainable, survivable futures. We have motivated that alongside current and even inherited perfumed 'smellscapes' crafted and conveyed by commercial concerns, there may be alternate posthumanist positioned scenarios and modes of engaging aromatically with changing living futures environments.

As Iovino and Oppermann (2013: Kindle) observe, '… a nonanthropocentric humanism debunks ontological hierarchies and rejects totalizing moral systems. Like an ethical/ontological prism, this vision reveals the landscapes of our partnerships, building new narratives of hybridity, participation, and coevolution.' Human imaginaries will still need to be part of posthumanist designs, though emerging developments in robotics and Artificial Intelligence and autonomous systems are already impacting on posthumanist agencies – along with and wanted and unwished for consequences – where human agency will still need to be negotiated. We might well heed the words of Auger and Hanna (2019: 196) when they caution that:

> We should expect design to contribute to the shaping of future narratives and aspirations, instead of merely implementing them. Design must provide imaginative, inclusive and sustainable goals to offset the uninspired visions and colourless futures presented by policy makers and corporations.

Through the *XIANGVEI* project we developed proto-scenting devices as a speculative, proleptic means to 'smell the future'. As sensory devices between the human and nonhuman, these artifacts indicate just some of the possible pathways to explore relations between changing scents and climates of change. Consequently, we suggest that attention to smell and to working speculatively with the olfactory are likely candidates for further design located investigations into relations between ecology and posthumanist inquiry into 'senses of the future'. These are relational anticipatory design futures that are realised and constituted as multi-sensory, eco-cultural and socio-technical in character, circulation and meaning, akin to Hsu's aesthetic work on reframing olfactory perception, the cultural and ecological (Hsu 2020: 201). Such a reframing of the 'atmospheric', embodied and olfactory in the context of the global pandemic around COVID-19 has recently appeared in Oslo through an exhibition of the body of work of the Norwegian olfactory artist Sissel Tolaas.[11] Tolaas' artworks are polysemic: profound and playful, technical and environmental, creative and technical. They connect the personal, systemic, bio-chemical and ecological. With social distancing and mask wearing currently deemed unnecessary by government, this artistic exhibition has enveloped on site public engagement of the embodied power and intangible dynamics of olfactory in postnormal times.

In a mode of anticipation, Speculative Design makes use of techniques such as storytelling and prototyping that are familiar to designers and design futures researchers and may be addressed to exploring life styles and forms that have a plurality of meanings in a non-binary view of human and nonhuman participants. Acknowledging this polysemy may serve to further accentuate holistic aspects of the cultural, ecological and technical in shaping Anticipatory Design. Equally, speculating about future life styles and forms by co-creative making and active critique may itself become an active part of future sustainable transformation in which we sharpen our anticipatory senses conceptually and work onwards into embodied sustainable futures experiences and culturally accentuated life styles.

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Yue Zou

SPECULATING ON DESIGN, LIFE STYLES AND FORMS

Studies in the Contexts of Climate Change and Sustainability

This thesis argues for an Eco-Cultural-Techno Design Speculative Approach to understanding the problems and potentials of long-term sustainable transformations. It presents a practice-based design speculative inquiry and related processes for designing Eco-Cultural-Techno futures. The research considers posthumanist notions and practices of Life Forms and Life Styles, encompassing nonbinary, nondualist, non-anthropocentric views and relational thinking. Based on this emergent viewpoint on posthumanism, Life Forms and Life Styles, the research consists of two heuristic and speculative design studies that offer critiques of the field of cosmetics and consumer culture through two projects, LO and XIANGVEI, that explore alternative conceptualisations and new relationships of design-based Eco-Cultural-Techno futures. Structurally, the study takes the format of an article-based thesis bound together by an exegesis.

The thesis offers three overarching contributions to design research. The first is a conceptual approach based on design-centred, posthumanist notions of Life Forms and Life Styles to investigate Eco-Cultural-Techno futures for transitioning to long-term sustainability. It also offers a Speculative Life-Style-Form Design Perspective through which this Approach may be read in greater depth. Second, the thesis demonstrates the design-inflected possibilities of multisensory and cooperative futures that could contribute to rethinking and supporting long-term sustainability. Third, the inquiry indicates that practice-based investigations through speculative design may highlight and elevate the potential to facilitate plural spaces for sustainable transitions. The thesis closes with a discussion of the possible directions for future research, including making connections between imagination, climate change and design and the means of implementing these ideas in design research, education, culture and policy.

Yue Zou is a transdisciplinary designer and design researcher. He is conducting speculations on the future of sustainable everyday life by combining design research and design practices and bringing further studies of posthumanism in design.

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