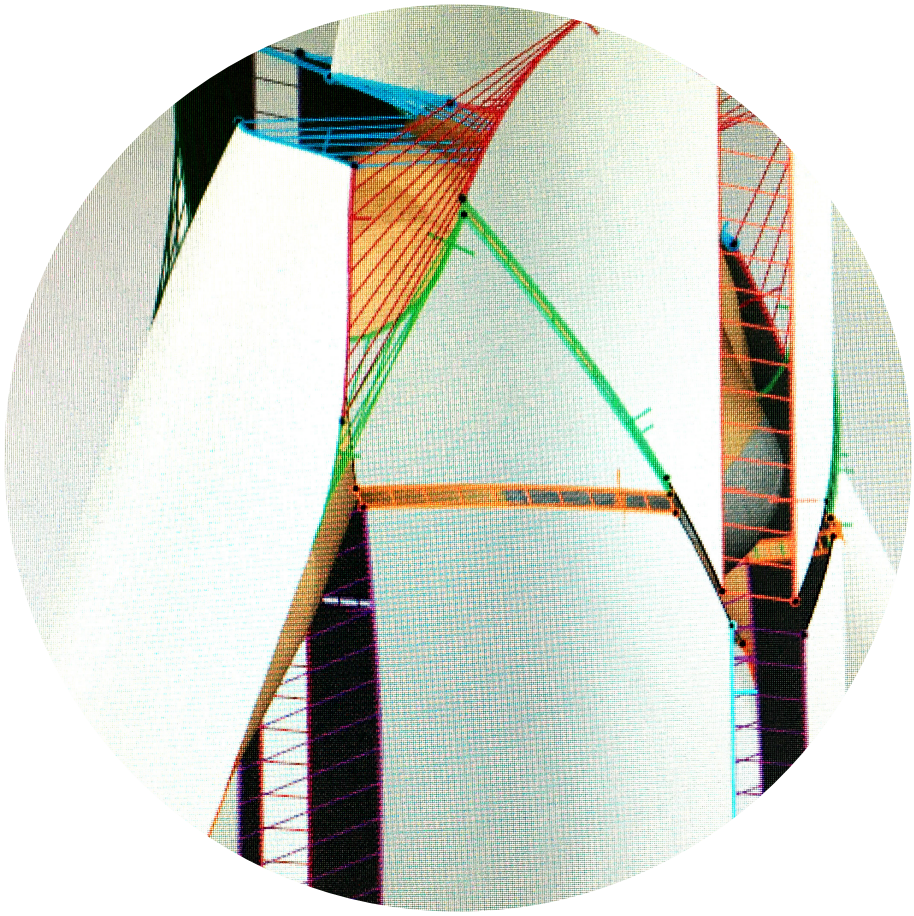
Department of Design

From a Tool to a Culture

Authorship and Professionalism of Fashion 4.0 Designers in Contemporary Digital Environments

Natalia Särmäkari



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Authorship and Professionalism of Fashion 4.0 Designers in Contemporary Digital Environments

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Abstract

This doctoral thesis investigates how the field of fashion design is affected by the current transformations in technological environments of "fashion 4.0". Contributing to fashion studies and design research, the theoretical framework of this qualitative research draws from authorship theorisation, sociology of professions and posthumanism. The empirical multiple-case-study research focuses on four pioneering, technologically advanced fashion 4.0 fashion design practices, where creation takes place in virtual spaces and is shared with non-professionals, networks or machines. The case studies are The Fabricant, Atacac, Self-Assembly and Minuju. The primary data were collected ethnographically through semi-structured interviews and field observation, and supplemented with written or spoken material generated by the cases. The secondary data consisted of media publications on the cases. Research material is analysed using the reflexive thematic analysis method.

The article-based thesis consists of four publications and an introduction. Publication I, "From Worth to Algorithms: The Role and Dimensions of Authorship in the Field(s) of Fashion Design", is a conceptual investigation of fashion designers' authorship in relation to their profession and contemporary digital practices. Publication II, "Open-Source Philosophy in Fashion Design: Contesting Authorship Conventions and Professionalism", delves into open-source philosophy as a design approach that contests conventional fashion designership, analysing the phenomenon through three empirical case studies. Publication III, "Digital 3D Fashion Designers: Cases of Atacac and The Fabricant", looks closely at two case studies that represent the rise of digital(-only) fashion and liquify the boundaries of fashion designership. Publication IV, "'Just Hit a Button!' – Fashion 4.0 Designers as Cyborgs, Experimenting and Designing with Generative Algorithms" explores algorithmic fashion design as a posthuman dimension of designership and proposes the concept of a cyborg designer.

The thesis provides new knowledge on the authorship and professionalism of fashion 4.0 designers operating in the digitalised society. It is argued that the new (sub)field of digital fashion contributes to the re-professionalisation of fashion design through open-source philosophy, posthuman discourse, intellectualisation of fashion practice, novel employment possibilities and entry into the gaming and technology fields. Fashion 4.0 practices are changing the ideal of fashion design from the autonomous designer to a community player and metathinker who adjusts their skills depending on projects, collaborators and co-creators. The fleshiness of fashion design transpires in digital fashion practices in which designers use digital technologies as design companions, ledgers of their tacit knowledge, sites and materials of creation. Fashion 4.0 designers are characterised by fluidity between digital technologies, human networks and physical realities.

Keywords fashion designer, authorship, professionalism, digital fashion, fashion 4.0

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Helsinki, 9 June 2022
Natalia Särmäkari

Contents

List of Publications

This doctoral thesis consists of a compilatory introduction and the following publications referred to in the text by their numerals. The articles are numbered in their order of writing and appended in their published form at the end of the thesis.

I. Särmäkari, Natalia. 2020. "From Worth to Algorithms: The Role and Dimensions of Authorship in the Field(s) of Fashion Design". Chapter 11 in *Aesthetics in Dialogue: Applying Philosophy of Art in a Global World* edited by Zoltán Somhegyi and Max Ryynänen, 149–167. Berlin: Peter Lang. https://doi.org/10.3726/b16690.

II. Särmäkari, Natalia, and Annamari Vänskä. 2020. "Open-Source Philosophy in Fashion Design: Contesting Authorship Conventions and Professionalism." *Synergy – DRS International Conference 2020*, Brisbane, 11–14 August, proceedings edited by Stella Boess, Ming Cheung and Rebecca Cain, 2410–2426. https://doi.org/10.21606/drs.2020.195.

III. Särmäkari, Natalia. 2021. "Digital 3D Fashion Designers: Cases of Atacac and The Fabricant." *Fashion Theory*. https://doi.org/10.1080/1362704X.2021.1981657.

IV. Särmäkari, Natalia, and Annamari Vanskä. 2022. "'Just Hit a Button!' – Fashion 4.0 Designers as Cyborgs, Experimenting and Designing with Generative Algorithms." *International Journal of Fashion Design, Technology and Education* 15 (2): 211–220. https://doi.org/10.1080/17543266.2021.1991005.

Author's Contribution

Publication I: From Worth to Algorithms: The Role and Dimensions of Authorship in the Field(s) of Fashion Design

Sole author

Publication II: Open-Source Philosophy in Fashion Design: Contesting Authorship Conventions and Professionalism

I was responsible for literature review, data collection, transcription, data management and analysis, writing drafts and finalising the manuscript, including working on images, tables, references, and proofs, submitting and revising the article, and corresponding with the publisher. As the article was published in conference proceedings, I also presented the article at the conference. Annamari Vänskä, my thesis supervisor, devised the focus and scope of the article, commented actively on article versions and made additions to the draft. She also actively edited the manuscript before publishing.

Publication III: Digital 3D Fashion Designers: Cases of Atacac and The Fabricant

Sole author

Publication IV: 'Just Hit a Button!' – Fashion 4.0 Designers as Cyborgs, Experimenting and Designing with Generative Algorithms

I was responsible for literature review, data collection, transcription, data management and analysis, as well as writing drafts and finalising manuscripts, including working on images, tables, references, and proofs, submitting and revising the article, and corresponding with the publisher. The role of Annamari Vänskä was to devise the focus, scope and theoretical framework of the article, to comment on and make additions to the drafts, actively edit the manuscript, and contribute to the revisions after the peer reviews and before publishing the final draft.

1. Introduction

The fashion world has undergone significant turbulence since I first started my fashion design studies in 2002. Already then, twenty years ago, I was puzzled by the contradictions in the field. On the one hand, fashion design was still very conservative, with design processes that did not seem to differ much from what they had been 150 years before. On the other hand, the field also pursued newness and innovation. I felt another contradiction between the myth of the artist and the hands-on nature of the actual work. Fashion designers were and still are expected to be unique and original *auteurs*, to the point that some of my classmates were covering their sketches with their hands to keep anyone from copying them. In reality, the team affects the design, the use of creativity is often limited by functional, material and market constraints, and copying is normalised – and even without it, we all somehow magically come up with similar ideas at specific times.

Even if the profession has not dramatically changed during the past twenty years, communication technologies have shaken the power structures and professionalism of almost every field, including fashion. Bloggers and influencers have become essential players in the distribution of fashion, and runways have turned from closed events to instantly broadcast digital spectacles in which anyone can participate. The employment of fashion designers is not self-evident, let alone balanced, well-paid or sustainable. The fashion industry has faced extensive critique and is expected to tackle ongoing environmental, social, cultural and economic issues. Designers are unsettled by ethical questions, seeking answers in technological possibilities and novel design philosophies. Since the invention of electricity and computers, fashion has grown into one of the biggest global industries. Today, developing intelligent digital environments are positing questions about the authorship and professionalism of fashion designers. “Digital fashion” increasingly dominates the professional discourse. As a researcher, I wanted to step back from designing and immerse myself in others’ practices during this transitional moment in the history of fashion, which only intensified between 2018–2022, especially during the pandemic and after I had started my doctoral research journey. It feels that something that was quite marginal in 2017 has now become mainstream in this relatively short period of time.

1.1 Background: the transforming figure of the fashion designer

I learned about the prospects of digital fashion during my fieldwork at the Swedish fashion company Atacac, one of the first to adopt digital 3D tools and develop a novel business model on that basis. The designer (mirthfully) said that: "[p]otentially Comme des Garçons could sell one [digital] outfit to Lady Gaga, and then sell a million of them online and stop doing handbags and perfumes since there are so many [digital] garments" (interview, 8 March 2019). He also told me about The Fabricant ("it's like a bit comparable to what we do, but *only* digital"), which I contacted soon after. The Fabricant, a Dutch "digital-only fashion house", was about to become famous with their USD 9,500 digital-only *Iridescence* dress, sold at a blockchain auction in May 2019.[1] My study, searching the ground between post-industrial fashion practices, artificial intelligence (AI) fashion and digital mass-customisation, found a new, essential twist.

Digital fashion has become a buzzword in the industry and education, and it has several meanings. First, it refers to digital *tools* used to assist in design processes, communication, showroom activities, sales and experiences. Second, it refers to digital *end-products*, either digital-only outfits in virtual spaces, virtual representations of physical garments or garments that incorporate digital technology. Third, it refers to a novel *fashion culture* that builds its own discourse, values and differentiation strategies, driven by the contemporary challenges of the fashion industry, technological possibilities and attitudes of digital culture. Fashion media, consultants and fashion technology influencers have been actively writing about "the rise of digital fashion" since 2019 (e.g. Milne 2019; Renwick 2019; McDowell 2019; 2020; 2021; 2022; Cosco 2020; BoF and McKinsey 2019; 2020; 2021). The discussion has ranged from the questions of wearing clothes that "don't exist," sustainability benefits, monetisation opportunities, "digital design flipping the current structure of the industry on its head" and disrupting the "broken system" (Godwin 2019; Milne 2019; Roberts-Islam 2020; Yugen 2021; Lyst and The Fabricant 2021) to fashion in games and the evolving metaverse, sounding "crazy… until it doesn't" (Evans 2019; Yotka 2020; 2021; Palumbo 2021; Nguyen 2022). Before this, AI in fashion was scrutinised as the next digital step to "replace the designer" or, at least, shake the dynamics of the fashion industry (Knight 2017; Cao 2018; BoF and McKinsey 2017; 2018), or in the sense of digital mass-customisation becoming the "future of fashion" (Hobson 2015).

In academic discourse, the concept of digital fashion broadly refers to all the digitised processes of fashion production, marketing, manufacturing and consumption, from virtual fitting to wearables and the Internet of Things (e.g. Noris et al. 2021; Nobile et al. 2021; Moore 2021). In media discourse, digital fashion typically refers to *digital 3D fashion* created using 3D software and producing digital 3D models of garments (see e.g. McDowell 2019). Digital 3D outfits can be worn by physical bodies on screens, such as in an augmented reality (AR) experience in an Instagram story or tailored onto photographed

[1] See https://www.thefabricant.com/iridescence [accessed 16 February 2022]

bodies. Digital 3D garments can also provide virtual reality (VR) experiences when worn by digital twins or avatars (Pires et al. 2019; Watstein and Czarnecki 2010). Besides self-expression in virtual spaces and social media, digital 3D garments can be used in virtual fitting services (Lee, Xu and Porterfield 2021). Furthermore, digital 3D fashion refers to the "skins" in social video games, worn by avatars that may or may not represent the wearers' physical bodies (e.g. Spahiu, Shehi and Piperi 2015). Realistic or fictional, the players' real bodies are enmeshed with the virtual ones (Biocca 1997), and digital dress is as performative as the physical dress (Makryonitis 2018). For example, the Animal Crossing game for Nintendo Switch became a bestseller during the pandemic spring of 2020 (Yotka 2020). The game operates in the intersection of the gaming and fashion industries as a platform for luxury fashion brands, streetwear companies and any type of user-generated fan fashion. Digital 3D tools for design are rapidly entering the industry and fashion schools. For example, Parsons School of Design (New York) included CLO3D software in their fashion design curriculum, finding this educational solution convenient during COVID-19 lockdowns and – most importantly – giving the students prospects in the changing world (Särmäkari 2021b).[2]

I argue that *digital fashion designers* who use digital 3D tools when designing for and in virtual spaces are a novel professional group in the field of fashion. Digital 3D fashion designers have not been studied in academia, apart from practice-based research on digital imagery (e.g. Harris 2005; 2013) and 3D modelling in fashion design processes (e.g. Arribas and Alfaro 2018; Makryniotis 2015). Therefore, I wanted to study how these professionals entered the world of fashion in this transitional moment in fashion history. "Digital fashion designer" refers to a designer who works with a wide variety of novel technological applications: I ascribe *algorithmic fashion design* processes also to digital fashion designers. By algorithmic fashion design, I refer to fashion design processes that utilise data analytics, artificial intelligence and automation. An algorithmic fashion designer "metathinks" while designing the garments *and* the processes and algorithms underlying fashion design. Designers with coding skills, an *open-source* attitude and service orientation may go further and build systems that enable user participation. Digital fashion designers' expertise, processes and design philosophies are affected by the latest digital technologies that comprise *fashion 4.0*.

I use the term *fashion 4.0* as the main context for digital fashion designers. Fashion 4.0 refers to fashion practices in "Industry 4.0" (Bertola and Teunissen 2018) or the *fourth industrial revolution* (Schwab 2016). This revolution builds on the third industrial revolution, also known as the Digital Revolution or the Information Age (Castells 2010). The major incentives of Industry 4.0 are *datafication* (van Dijck 2014; Mayer-Schönberger and Cukier 2013),

[2] See a conversation (19 March 2021) between Soojin Kang, Adjunct Professor at Parsons, and Francesca Sammaritano, Interim Dean at Parsons, who started a digital 3D fashion design course in 2019 https://www.youtube.com/watch?v=TRa8IWqUK3Q [accessed 10 February 2022]. I also met and interviewed the teachers in March 2020, just before the lockdown in New York, where I was staying as a visiting Fulbright scholar at Parsons.

decentralisation and the use of blockchain technologies in *Web 3.0*,[3] merging physical and digital worlds as artificial intelligence advances (Sheth and Thirunarayan 2012; Schwab 2016; Hernandez, Vogelsteller and Sieler 2020). Fashion 4.0 incorporates these principles and is manifested in smart factories, networks and products, touching upon everything from design and research to manufacturing, retail, products and stock (Bertola and Teunissen 2018, 355). Fashion 4.0 restructures operations and relations within the fashion industry, reshaping the required expertise and professional roles.

Focusing on fashion designers, I argue that two of the fashion 4.0 phenomena that fundamentally redefine designership are digital and algorithmic design. Both phenomena entail discourse on decentralisation, de-artification and de-professionalisation of fashion design, already proposed in earlier stages of the fashion industry (Crane 2019; Crewe 2017; Van de Peer 2014; von Busch 2008), and especially associated with digital environments. According to Louise Crewe (2017, 130), digital communication technologies are "probing and perforating the boundaries between firms and consumers, production and consumption, object and image, material and virtual," while digital technologies are "enabling the devolution of fashion authority from traditional power brokers such as magazine editors and designers toward a more diversified assemblage of participants." This is also the case in fashion 4.0 design practices, where digital technologies are not only used for design, communication, manufacturing and retail but also for building an explicitly revolutionary fashion culture. This culture builds on the broader essence of digital culture in which everybody can design, and the glorified role of the designer is questioned (Bollier and Racine 2005; von Busch 2008; Manzini 2015; Hermans 2015).

Fashion designers are traditionally considered as central, collectively legitimised figures in the fashion industry and culture because they "personify" clothes (or other objects that they present in the fashion context) and turn them into fashion (Kawamura 2018, 55–70). The *figure* of a fashion designer is complex, contextual and fluid: it embodies and merges diverse figures, from eccentric couturiers and conceptual designers to pragmatic synthesisers of brand image, trends and consumer demands (Lipovetsky 1994; Crane 2019; McRobbie 1998; Volonté 2012; Vangkilde 2017; Loschek 2009). I borrow the term *figure* from Paolo Volonté (2012) to refer to the fashion designer as an object of sociological investigation, but also from Donna Haraway (1997), to locate the fashion designer in a particular sociotechnical discourse and environment, shaped by industrialisation, capitalism and the situated author-function (Foucault 1998 [1969]).

The author-function of the traditional fashion designer is adopted from the Modern or Romantic notion of authorship related to the concept of art: an artist

[3] Web 3.0, also known as the "semantic web", contrasts with the previous stages of Web 1.0 – the internet – and Web 2.0 – user-generated content and centralised "Big Tech". Web 3.0 refers to the data-intensive and interoperable systems that merge the digital and the physical worlds, for example in the form of the Internet of Things (Sheth and Thirunarayan 2012) and now increasingly associated with cryptocurrency, decentralised systems and the tokenised assets on the blockchain, typically non-fungible tokens i.e. NFTs (Hernandez, Vogelsteller and Sieler 2020; Livni 2021).

or author who originates works of art (Bennett 2005; Woodmansee 1994; see Publication I). One of the premises of this thesis is that the Modern notion of authorship is a key element of professionalism and professionalisation in fashion design. Therefore, it should be investigated in the sociocultural/technological circumstances wherein authorships of any kind are challenged and scrutinised. Many fashion scholars have criticised the myth of the creative genius designer, seeing it as gendered, neoliberal and simply false against the realities of design work, where designers collaborate, interact and negotiate with complex networks of individuals, institutions and technologies (e.g. Blumer 1969; Crane 1993; 1999; 2019; McRobbie 1998; Mora 2006; Kawamura 2004; 2018; von Busch 2008; 2012; Huopalainen 2016; Moon 2016; Vangkilde 2017). Fashion design balances between authorship and impersonality. Current technological environments are reconstructing the dynamics between fashion designers, producers and user-consumers (Sun and Zhao 2018), raising questions on the fashion designer's *professional* and *authorial* figure.

Professionalism is the way of institutionalising expertise in industrialised societies (Abbott 1988, 323). To avoid objectification of the complex nature of professions and the hierarchical division between "professions" and "occupations" or "professions" and "semi-professions" (Beckman 1990), I follow Andrew Abbott's (1988, 318) loose definition of professions as "somewhat exclusive groups of individuals applying somewhat abstract knowledge to particular cases," which implies that the question of whether an occupation is a profession is not important (Valtonen 2007, 29). The distinction between professions and occupations has been gendered, as the traditionally prestigious professions such as doctor and architect were male-dominated, whereas occupations or semi-professions such as nurse and interior designer are considered feminine (Aaltonen 2010). Though fashion design is not a licensed profession and the legitimation of (especially self-taught) designers is often executed by means other than education (Kawamura 2018, 55), I intentionally refer to *fashion design* as a profession. I believe that fashion designers have not had the social recognition they deserve as key figures in the global fashion business and culture. However, I will not ignore the hierarchies between and within professions and the importance of the notion of *professionalisation*. Professionalisation refers to processes that aim at achieving a protected institutional market position for the services they provide, a socially and culturally legitimised expertise and status (Larson 1977; Beckman 1990; Abbott 1988; Siegrist 2001, 12154). These processes encompass different professionalisation *strategies* that contribute to the elevation of the profession's social status, such as linking fashion design practice to art (Shapiro and Heinich 2012) or other values that dominate our culture and the fashion system.

In this study, the fashion system refers to the system of fashion production, the professional *field* of fashion, and especially the *field of fashion design*. This field has implicit, dynamic rules where different players build their professional jurisdictions and legitimisation strategies (Bourdieu 1993b; Abbott 1988; Kawamura 2018). *Professional jurisdictions* give professions the right to define

and dominate certain tasks and solve certain problems (Abbott 1988, 87). The fashion industry and its supply chain encompass the production of raw materials and textiles; design, product development and manufacturing; distribution and marketing; sales and retail; and, increasingly, post-consumption disposal, re-use activities and the second-hand market (Kawamura 2018; Blaszczyk and Pouillard 2018). The *fashion system* has been discussed by many scholars from cultural, social, economic and technological viewpoints (e.g. Barthes 1990 [1967]: Kawamura 2018; Lipovetsky 1994; Crane 2000; Entwistle 2000b; Leopold 1992). Thus, the term refers to artistic fashion practices and the global fashion industry, with actors designing, producing, distributing and consuming attire; as well as to something beyond clothing, a more-than-human network (Leopold 1992; Blaszczyk and Pouillard 2018; Kawamura 2018; Entwistle 2000b; Wilson 2013 [1985]; Vänskä 2017b; 2018; 2021; Barthes 1990 [1967]).

Roland Barthes (1990 [1967]) defined fashion as a semiotic system and a form of culturally codified language that reflects the ideologies, social structures and societies. After Barthes, the analysis of fashion as a communicative system has been widely applied – to texts, visual representations of fashion and actual garments alike; among these are scholars such as Fred Davis (1992), Alison Lurie (1981), Malcolm Barnard (1996), Joanne Entwistle (2000a), Annamari Vänskä (2017b) and Yuniya Kawamura (2004; 2018 [2005]). This system also constructs the myth and figure of the fashion designer. Fashion sociologists have studied the social aspects of fashion design practices and the relationship between the various players that form the fashion system (e.g. Crane 1999; Mora 2006; Kawamura 2018; Rocamora 2016): designers, clothing producers and the supply chain, institutions, museums, fashion media, retail and, lately, user-generated content creators (bloggers and influencers). Here the system stands for the fashion worlds, similar to Howard Becker's (1982) notion of the art worlds and the institutional theory of art, proposed by Arthur Danto (1964) and George Dickie (1974).[4] According to these theories, the discourse and the social institutions of the art world (artists, curators, funders etc.) define what is art and who is an artist.

The fashion system reflects the role of fashion and clothes in human lives. People have long used clothes and accessories, and yet it is debated whether *fashion* is a Modern and Western phenomenon or an earlier, global and universal one (Lipovetsky 1994; Kawamura 2018; Belfanti 2008; Godart 2012; Aspers and Godart 2013; Wilson 2013 [1985]; Tortora 2015; Almila 2016). Fashion is "a mixture of affective, cultural and economic influences and intensities" (Huopalainen 2016, 70). As Amber Jae Slooten, the head designer of one of my case studies, The Fabricant, pointed out in our conversation, fashion has two layers: a virtual layer through which we express ourselves, and a functional layer that protects us and our bodies. The virtual layer is fashion, an intangible cultural object symbolically manifested in clothing, and the functional layer also materialises fashion (Vänskä 2021; Kawamura 2004, 2–3).

[4] Dickie reworked this theory in 1983 into a "New Institutional Theory of Art", published in the Proceedings of the 8th Wittgenstein Symposium, 10, pp. 57-64.

Fashion is what we understand as culture: an innovation might generate a chain reaction if a shift (fashion) resonates in the culture, touches the emotions and stirs the imagination of other creators, retailers, publishers and consumers (Blaszczyk 2008, 3–4; Aspers and Godart 2013). For their livelihoods, fashion producers depend on their ability to understand and detect the changing fashions trickling across highbrow and mass-market tastes (ibid.). Turning the spirit of the time, the "zeitgeist" (Vinken 2005), into clothing is one of the critical skills of fashion designers. The zeitgeist is not limited to passing trends: it is also the culture of practising, conceptualising and approaching fashion. The structures of the "game" in the field of fashion, including the hierarchies, the notion of authorship and values of designership, are part of the zeitgeist shaped by discourses, world events, economic transformations – and technologies.

The term *technology* refers to tools, techniques and processes, and ranges from very simple ones, such as awls, needles and scissors, to highly complex ones, such as smart wearables and computerised production (Tortora 2015). Technologies are essential in fashion culture and industry, as they are used in everything from communication, design, production and transportation to retail, consumption and recycling. Fashion has always reflected, affected and even considered itself the history of technology (Quinn 2002, 3; Lee 2005, 15; Tortora 2015, 1; Genova and Moriwaki 2016, 4). Production technologies have co-evolved with designers, society and consumer desires (Breward 1995; 2003; Bolton 2016; Scheffer 2008). Technology and its users shape each other, and technological changes trigger social transformations – including fashion – which further technology's evolution (Sun and Zhao 2018, 362; Tortora 2015). The key factors behind contemporary fashion are new media technologies, which started with the printing press. Technologies have become new arenas of fashion creation: for example, photography and motion pictures not only document fashion but also create it (e.g. Vänskä 2017b; Aspers 2006; Evans 2011, 110). Communication technologies provide means for fashion dissemination and distribution, and for collaboration among designers and manufacturing teams. Technologies have defined how and what kinds of clothes were made. Before sharp metal devices were invented, allowing cut-and-sew techniques, rectangular garment pieces were wrapped and draped around the body (Tortora 2015, 40; Lindqvist 2015, 59). Production technologies set the boundaries of design possibilities. Transportation technologies move fashion products around the globe. The need to efficiently produce cotton in Europe instead of India sparked technological inventions that arguably led to the industrial revolution (Breward 1995, 127–130; Breward 2003, 23) – or the *first* industrial revolution (Bertola and Teunissen 2018). Thus, it was not industrialisation alone that determined the direction of the fashion system, but also vice versa. By the late 18th century, there were water and steam-powered mills across Europe and the United States. Together with the textile industry, the fashion industry began to emerge. The industrial revolution brought global socio-cultural changes, including those inflicted by the American Revolution (1776) and French Revolutions (1789, 1830 and 1848).

When the French and Central-European societies turned more democratic and social distinction became more fluid, authority in fashion shifted from the royal courts to couturiers, engendering a need for efficient production of simpler fabrics and clothes (Kawamura 2004, 31–32). The rise of the bourgeoisie and industrialisation established a fertile ground for the profession of the *fashion designer*, who typically creates clothes and accessories and, simultaneously, adds value to products (e.g. Manlow 2007; Almila 2016). The mechanisation of transportation and production – including the invention of the sewing machine in the 1840s[5] – made dressmaking faster and cheaper, enabling larger production volumes and *detaching the designer from the maker*. In the age of reproducibility (Benjamin 2007 [1935]), where unique objects ceased to be direct traces of their makers, the works needed to have a name and an artist behind the ideas (Woodmansee 1994). Thus, the profession of fashion designer could be argued to exist due to the *industrial revolution* and the subsequent societal, cultural and economic transformations. Larger and more diverse groups of individuals could be part of fashion processes. However, only wealthy consumers could afford fine French *couture* and tailormade suits (Lipovetsky 1994). The higher classes continued to be dressed by ateliers, whereas the rest of society was interested in fashionability in urban social environments. Women were entering the workforce and did not have time to make garments for themselves and their families; therefore, there was a need for affordable yet innovative, ready-made clothing (Tortora 2015, 136; Kawamura 2018; Leopold 1992).

With the *second* industrial revolution of the late 19th century came electricity, photography, film, synthetic textile innovations and mass production, significantly widening the palette of fashion designers' possibilities (Evans 2011). However, the fashion industry developed slowly compared to the mass-production abilities of other industries (Breward 2003; Leopold 1992). The *third* industrial revolution, taking place from the late 1950s onwards, brought electronic innovations, computer-aided manufacturing (e.g. computerised, numerically controlled CNC machinery), communication technologies and, in the 1990s, the Internet and in the 2000s the Web 2.0 (Bertola and Teunissen 2018). This resulted in fierce globalisation, offshoring and the neoliberal post-industrial network society (Bell 1973; Castells 2010; Ampuja and Koivisto 2014). Computers and computer-aided design (CAD) enabled cross-continental communication and teamwork and provided a new tool and medium for creativity (Smelik 2021, 59). These technological transformations formed what this thesis calls the traditional professional fashion system, which consists of the physical and intellectual artistic dimensions of production and

[5] The sewing machine was first patented by Elias Howe in 1846. Isaac Singer patented an improved version in 1851 and was consequently sued by Howe. Both continued manufacturing sewing machines but Singer's marketing strategy proved more successful: he hired attractive young women to demonstrate the machines and their use in showrooms and collaborated with the church to gain respectability. The sewing machine changed fashion because it made laborious garment manufacture feasible even for home sewers (Tortora 2015, 134).

consumption, as well as various players responsible for overlapping layers of culture, commercial and apparel production.

Technological revolutions tend to affect working lives (Valtonen 2007; Abbott 1988). For example, industrial design, a neighbouring field of fashion design, was heavily affected by the third industrial revolution. Computing generated a profound reconstruction of the professional jurisdiction, resulting in new fields of user interface (UI) and user experience (UX) design (Valtonen 2007, 141). While the third industrial revolution and the participatory Web 2.0 decentralised and virtualised fashion's imagery, diffusion, distribution and embodied experience (Bendoni 2017; Shinkle 2013), the *fourth* industrial revolution – fashion 4.0 and Web 3.0 – decentralises, virtualises and datafies organisations, processes, products and the whole fashion culture (see Figure 1). Based on the transformations of other design fields and the intimate relationship between fashion design practice and technology, I hypothesise that fashion 4.0 is shaping the existing field of fashion design and pushing towards novel professional jurisdictions and legitimisation strategies – namely the ones constructed by digital fashion designers.

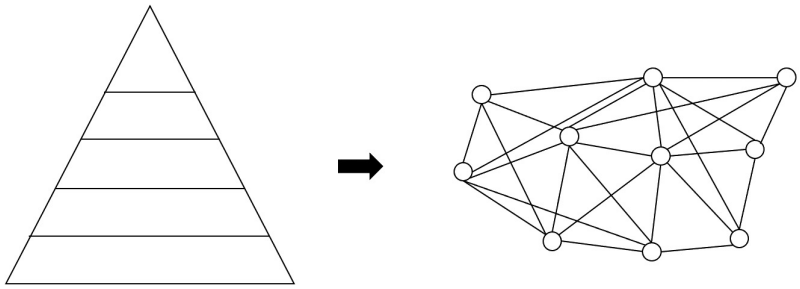

Figure 1. The hierarchical value structure of the fashion system versus a decentralised value structure of the fashion system. Design: Natalia Särmäkari.

1.2 Objectives and research questions

The objective of this thesis is to provide new theoretical and empirical knowledge on the contemporary figure of the fashion designer through case studies, where the designers or their workflows are digitalised. I approach the research topic by investigating practitioners. The focus is on contextualising and conceptualising current professional phenomena and studying, through concrete case studies, how the field of fashion design is transforming in the face of the fourth industrial revolution. Fashion as a broader phenomenon is studied in sociology, psychology, aesthetics, economics, cultural studies, anthropology, art history and combinations of these (Kawamura 2018; Tortora 2015). Most literature on fashion design and designers either is educational (e.g. Renfrew and Renfrew 2016; McKelvey and Munslow 2012) or focuses on successful "star" designers. Sociological investigation on fashion designers has touched upon

cultural, organisational, economic and societal specificities in certain locations (Gronow 1997; McRobbie 1998; 2015; 2016a; 2016b; Skov 2002; Volonté 2012; Kawamura 2004; 2018; Crane 1993; 2019). Empirical research on fashion design practices, processes and designers' roles has more widely attracted attention from anthropologists, economists, and design and fashion researchers in the last decades (e.g. Chun 2018; 2021; Vangkilde 2010; 2015; 2017; Aakko 2016; Kauppi 2021; Huopalainen 2016; Raebild, 2015; Ruppert-Stroescu and Hawley 2014; Bye and Sohn 2010; Rissanen 2007; Eckert and Stacey 2001; Sinha 2000 2002; Lamb and Kallal 1992; Vänskä, Hokka and Särmäkari 2022). My work contributes to this corpus of knowledge, especially to research on the emerging dimensions of fashion designership. In design research, fashion design has even fewer epistemological foundations than other design disciplines (Chun 2021; Nixon and Blakley 2012). Fashion studies, in turn, focuses less on design practice and more on the social and discursive side, on fashion as an embodied culture that contributes to the production of subjectivities (e.g. Wilson 2013 [1985]; Breward 1995, 2003; Entwistle 2000a; 2000b; Cole 2000; Kaiser 2012; Geczy and Karaminas 2017; Vänskä 2017b). Research on fashion design technology is mostly constructive or practice-based (e.g. Harris 2013; Baytar and Ashdown 2015; Makryniotis 2015; Mattila 2016; Kato et al. 2018; Kato et al. 2019; McQuillan 2020).

This study builds on research on the fashion design profession both in fashion studies and design research, and strives to make sense of practical research on fashion design technologies from a socio-philosophical – fashion authorship and profession – perspective. I have analysed a few representative yet unique cases from a socio-philosophical perspective rather than developing new practices. By doing so, I hoped to obtain and generate situated insights on how fashion designership is transforming in the current technological landscape.

This research project is qualitative and abductive; therefore, the research questions address "how" and "why" questions in unexplored research areas and combine a theory-driven approach with a phenomenon-based approach (Edmondson and McManus 2007; Eisenhardt and Graebner 2007, 27). This research contextualises within and extends the existing theories of sociology of professions and fashion design, and builds insights on the new and professionally significant complex phenomena that lack existing theories and empirical evidence (Eisenhardt and Graebner 2007, 26). To give research flexibility, I have scoped the main research question rather broadly: **How is the authorial and professional figure of fashion designers affected by contemporary technological environments and fashion 4.0?** This question serves as a hypothesis that fashion 4.0, as a transitional moment in fashion practices, impacts fashion designer designership. Research questions I-IV regard the phenomena and are divided according to the four articles that this thesis comprises. The research questions are:

RQ I: What is the role of authorship in the traditional figure of a professional fashion designer, and how could it be understood in the contemporary post-industrial society?

RQ II: How, why and to what end do fashion designers question the authorial and professional conventions of fashion design, applying an open-source philosophy?

RQ III: How and why are "digital fashion designers" building their practice on digital 3D design? How are they redefining fashion design culture and the role of the professional fashion designer? (How, why and to what extent does the phenomenon of "digital fashion" shape the ontology of the fashion design profession?)

RQ IV: How, why and to what extent do designers use generative algorithms in fashion design processes, and how does "algorithmic fashion design" contest the traditional figure of the fashion designer?

I developed research questions I, II, III and IV under the main question to conduct a theoretical investigation on the role of authorship in the fashion designer's profession and to focus on the three phenomena that I argue illuminate and characterise fashion design 4.0: open-source philosophy, digital fashion and algorithmic design. I revised the research questions throughout the research process. However, the main research question (*How is the authorial and professional figure of fashion designers affected by contemporary technological environments and fashion 4.0?*) did not change significantly. In the beginning, I asked how the authorship and professionalism of fashion designers are affected by contemporary technological environments. Later, when I encountered the concept of fashion 4.0, which is the context of the practices in question (Bertola and Teunissen 2018), I added the term to the main research question. I also added the term "authorial and professional figure of the fashion designer" in order to refer to the fashion designer as an object of sociological investigation (Volonté 2012) as well as a posthuman, material-semiotic actor (Hayles 1999; Haraway 1988; 1997). I added the posthuman lens to the research approach after my supervisor suggested it could be relevant when studying intimate collaboration between smart technologies and humans, and human activities in virtual worlds with digital bodies. Posthumanism resonates with the digital fashion discourse, aesthetics and attitudes on many levels: digital fashion as a phenomenon within the digital culture is characterised by tendencies towards decentralisation of power as well as blurred boundaries between organic and artificial, physical and virtual, and human and non-human – the same characteristics have been identified in posthuman fashion (Vänskä 2018; Smelik 2021).

The macro-context of this research is the current technological environment that I call Industry 4.0 (see Figure 2). Within this industry, digital culture, with its roots in the information revolution, is setting the artistic, intellectual and processual zeitgeist that entails open-source philosophy, virtualisation, datafication and the posthuman. Digital fashion emerges in the field of fashion 4.0 and post-industrial design that comprise smart factories, networks and

products, and implement digital tools to rethink the heavy structures of the bulk-based, overproducing fashion industry. This thesis constitutes a micro-context within the wider one: fashion designers' professional field and novel digital practices.

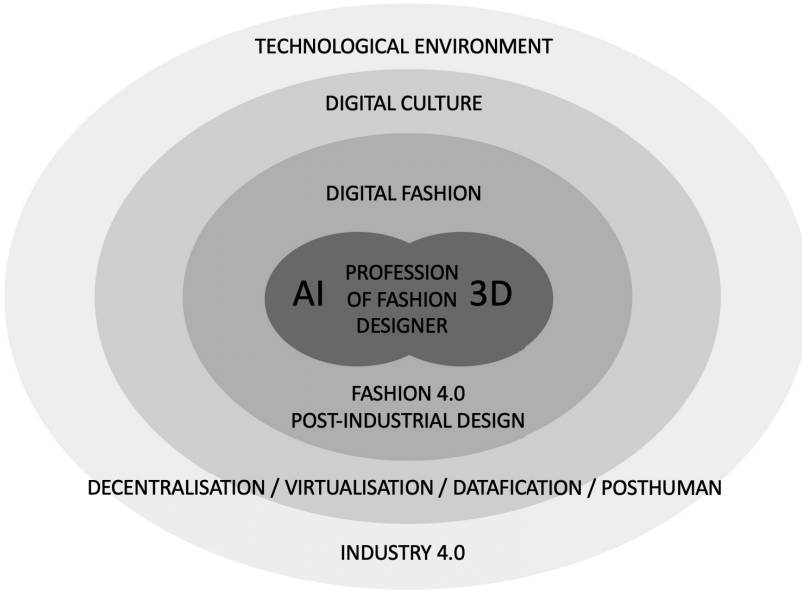

Figure 2. Contexts of research. Design: Natalia Särmäkari.

1.3 Research design

This research combines theoretical investigation with the empirical qualitative case study strategy. Its methodological choices reflect the underlying ontological and epistemological framework, as well as the research questions shaped by the context of this research and by what I, as a researcher, can do in the chosen setting (Denzin and Lincoln 2005, 4–6). Following Donna Haraway's notion of situated knowledges (1988) and echoing critical realism (Bhaskar 2010 [1989]), this research is based on the premise that my observation capacity is partial and there is a plurality of realities beyond human perception. I employ Haraway's (1985) concept of a posthuman cyborg with its "both-and" perspective: there is no contradiction between participation and observation because observation is always situated. Being a "subject" distantly looking at an "object" and enacting "a conquering gaze from nowhere" is an act of power (ibid., 581). I struck a balance between distancing myself and being part of the group that I studied.

The disciplinary set of socially constructed values provides the aims for the scientific method (Kuhn 1996; Longino 1990; Andersen and Hepburn 2020). For a long time, fashion was perceived as a frivolous, trivial and inferior object of serious study due to its feminine connotations, revealing the gendered

hierarchies of academia and serving as a site for feminist approaches (Wilson 2013 [1985]; Evans and Thornton 1989; Steele 1991; Craik 1993; Arnold 2000; Entwistle 2000b; Vänskä 2017a; Clark 2019). This anti-fashion attitude has waned and the study of fashion and dress has become a site of growing interest in the social sciences, humanities, business studies and design studies. The centrality of bodies, identities, pluralities and materialities links fashion studies to critical cultural studies approaches that draw from feminist methodologies, queer theory, race and ethnicity studies, and posthumanism (Kaiser 2012; Vänskä 2018; Smelik 2021).

Fashion studies and design research are methodologically manifold, ranging from practice-based research to ethnography, from engineering to philosophy – or combinations of all these (Kawamura 2011; Murphy 2017). There are no disciplinary matrices (paradigms) nor methodological "gold" standards to solve the shared puzzles of these two intertwined academic communities. Fashion studies avoid establishing exclusive paradigmatic boundaries and tend to include theories and methods from other fields (Jenss 2016; Granata 2012). In the field of design research, I am conducting research *into* design as I am studying the designer's profession in a particular historical moment and technological context (Frayling 1993). My approach is in contrast to what Frayling (1993) called research *through* or *for* design – approaches typically used in practice-based and constructive research, where knowledge is acquired through personal design practice, or research is conducted to gain insights for use in design.

During my first year of research, I mapped projects and practices worldwide (see Appendix 4) to understand the types of technological tendencies in fashion design. I collected the media and academic publications on fashion companies and projects that utilise and experiment with post-industrial digital technologies and artificial intelligence and, by doing so, explicitly or implicitly defy the designer-centred conventions of the fashion industry and redefine professionalism. I used search terms such as "digital fabrication in fashion", "post-industrial fashion", "fashion technology," "AI fashion", and "digital fashion design." I found that the "fashion tech" field could be divided roughly into four overlapping streams: 1) digital platforms and online services, 2) 3D technology, 3) artificial intelligence (including robotics in manufacturing), and 4) wearable technologies. In terms of the role of the fashion designer, technological streams 1–3 affect the designer's role directly in relation to human or non-human contributors, whereas in wearables, the focus is on the digitisation of the object, not the design process. I created forty-five files and a table (Appendix 4) with different projects according to their type of technologies, collaboration and core operations, competitive advantage, product, sector, designer's role, and location.

To understand the tacit dimensions of designers' knowledge, discern the relational networks, feel the environments where they work and dive deep into the overall complexity of the phenomena I was exploring, I chose the *case study strategy* that combines ethnography and document analysis (Yin 2018; Eisenhardt and Graebner 2007). It was important to observe how designers

relate to their tools and co-workers at their work sites. This approach is common in studying designers and design processes in the context of fashion, where the methods are typically in-depth interviews, oral histories, ethnography and autoethnography, and visual and archival research (Kawamura 2011; Jenss 2016). After a test interview, I realised that interviews could depict neither the complexity of designers' work nor the aspects that designers cannot express verbally. As Abbott (1988) has pointed out, it is essential to study what professionals actually do and in what kinds of environments. I focused on how fashion design professionals and technologies construct the contemporary, digitally affected figure of the fashion designer in their work and particular context. Though contextuality is important when studying professions (e.g. Konttinen 1993; Volonté 2012; McRobbie 1998; Sciulli 2008), I did not limit the scope to studying general fashion design professionalisation in a particular geographical or cultural location. Such a study would have demanded an entirely different research design (cf. Wiberg 1996; Valtonen 2007; Puustinen 2006). I decided to focus on the digitalisation of the profession by zooming into particular cases, the space and place of which are predominantly the digital realm.

I studied four technologically advanced design practices where creation happens in virtual spaces and/or is shared with non-professionals, networks or machines: *Matti Liimatainen/Self-Assembly (S-A), Minuju, Atacac* and *The Fabricant*. While doing research, I identified three main technology-related phenomena that affect contemporary fashion designership: *digital fashion, algorithmic fashion*, and *open-source fashion*, which were present in all the cases. These phenomena also defined the publication plan, which comprised one conceptual article about fashion designer authorship and one article focusing on each of the three phenomena (see Table 2). During the research process, I collected data on eight cases and conducted a qualitative online survey of "digital fashion designers" globally (see Table 1). However, during the writing process, I decided to focus on the cases above to ensure coherence and rigour. I collected extensive data on the cases that I found most significant because of their vanguard status, variety in approaches, and intense thematic relevance. In other words, I used a purposive sampling strategy, relying on my judgement and the expert status of the cases (Flick 2014, 175).

Table 1. Cases in relation to the studied phenomena. Cases 3–6 were selected for inclusion.

	Case 1 → lit. rev → interview	**Case 2** → lit. rev → interview	**Case 3** S-A	**Case 4** Minuju	**Case 5** Atacac	**Case 6** The Fabricant	**Case 7** Educational, Parsons → interview	**Case 8** Archival, Superficial → interview	**Survey** 42 digital fashion designers
"Algorithmic fashion"	X	X	X			X			
"Digital fashion"			X		X	X	X	X	X
"open-source fashion"	X	X	X	X	X	X		X	X

The research process, including data collection and analysis, was iterative and recursive, juggling between the data, emerging theory and literature (Eisenhardt and Graebner 2007). Each cases informed the next cases and the focus of my research. Literature guided the empirical investigation and vice versa. The dialogue between data and theory was constant, and reasoning was abductive (Collins and Stockton 2018; Timmermans and Tavory 2012). I started reviewing the literature when writing the research plan because sound empirical research begins with identifying a gap in the existing research to form tentative research questions (Eisenhardt and Graebner 2007, 26). Existing research on the profession and authorship of designers helped me develop and outline an understanding of the traditional professional figure of a fashion designer. I then used this understanding to make sense of the empirical data.

Following my supervisor's advice and research on posthuman fashion (Vänskä 2018), I found similarities between the discourse of the studied cases and posthumanists, highlighting the enmeshment and co-evolution between humans and non-human technologies (Haraway 1985; Hayles 1999; 2012). As a researcher, I produced new realities interactively with the case studies, and entangled with the people, their operating environments and the technologies they use. I conducted on-site observation and in-depth interviews and collected everything I could about the chosen cases: documents, company websites, publications, talks, social media content, images, and media articles. I netnographically (Kozinets, Dolbec and Earley 2014) followed their live discussions and streamed designing events. I also analysed and contextualised them through literature about the phenomena. Instead of searching for generalisations, I actively generated knowledge through reflexive thematic analysis (Braun and Clarke 2019). I processed all the data through my own memory, experiences, learned professional conventions and mental schemes, and the overall embodied cognition of what it means to be a dressed human being.

1.4 Thesis structure

This article-based thesis includes four peer-reviewed research articles and a compilation section, also called the introduction. The publication selection constitutes one book chapter (Publication I), one peer-reviewed conference paper (Publication II), and two journal articles (Publications III and IV). The compiling introduction part comprises five chapters that present the scope and methodology of this research, summarise the articles and discuss the contribution of this thesis. The compilation part is structured as follows: Chapter 1 introduces the research topic and its background, the objectives, research questions, methodological approach and the structure of this thesis. Chapter 2 frames the scope, contexts and theoretical foundations. Chapter 3 presents the methods. Chapter 4 proposes the key arguments and summarises the findings in relation to the research questions. Chapter 5 summarises the contribution of the research project and discusses its practical and theoretical

implications. It also provides a reflection on the findings and addresses the rigour and limitations of my research, recommendations for further studies, and conclusions. The compilation section is followed by the original papers. Table 2 provides an overview of the publications.

Table 2. Overview of the publications.

Publication	Keywords	Research questions	Research approach	Contribution
I From Worth to Algorithms: The Role and Dimensions of Authorship in the Field(s) of Fashion Design BOOK CHAPTER	authorship, fashion designer, field theory, author function, artification, deauthorisation, postindustrial technology	What is the role of authorship in the traditional figure of a professional fashion designer, and how could it be understood in the contemporary post-industrial society? (RQ I)	Conceptual / theoretical article in an academic book in the field of aesthetics/art theory.	Conceptualisation of the authorial and professional figure of the fashion designer, historically and today. Conceptual framework for following case study articles.
II Open-Source Philosophy in Fashion Design: Contesting Authorship Conventions and Professionalism CONFERENCE PAPER	open-source philosophy; fashion designer; authorship; professionalism	How, why and to what end do fashion designers question the authorial and professional conventions of fashion design, applying an open-source philosophy? (RQ II)	Three case studies: qualitative data collection and thematic analysis. Interviews, observation + secondary research material. Design research conference proceedings *DRS*.	Framing "open-source fashion", its elements and relation to the traditional fashion system and the figure of the designer. Drivers, enablers and limitations of such an approach. Four themes.
III Digital 3D Fashion Designers: Cases of Atacac and The Fabricant JOURNAL ARTICLE	digital fashion, figure of fashion designer, fashion 4.0, 3D technology, professionalism	How and why are "digital fashion designers" building their practice on digital 3D design? How are they redefining fashion design culture and the role of the professional fashion designer? (RQ III)	Two case studies: qualitative data collection and thematic analysis. Interviews, observation + secondary research material. *Fashion Theory* - journal. Fashion studies/humanities.	Zooming into cases that represent two different approaches to digital fashion and, as forerunners, build this novel culture. Merging other fields, new prof. jurisdiction, Re-professionalis., digital artisans.
IV "Just Hit a Button!" – Fashion Designers as Cyborgs, Experimenting and Designing with Generative Algorithms JOURNAL ARTICLE	algorithmic design, fashion designer, digital fashion, cyborg, professionalism	How, why and to what extent do designers use generative algorithms in fashion design processes, and how does "algorithmic fashion design" contest the traditional figure of the fashion designer? (RQ IV)	Two case studies: qualitative data collection and thematic analysis. Interviews, observation + secondary research material. Special issue on digital fashion innovation, *International Journal of Fashion Design, Technology and Education.*	In-depth study on two cases that collaborate with machines in different ways. Framing algorithmic fashion design, its approaches and possibilities. Proposing the concept of cyborg to understand these fashion designers.

2. Scope of the research

This research builds on the presumption that the profession of fashion design, the authorship of designers and the technological development of the field of fashion are all socially constructed, discursive and embodied. This assumption steers the theoretical underpinnings and focus of empirical study. The immaterial nature of digital design and non-human algorithmic design reveals how essential the fleshy body and tacit knowledge are in fashion design practice. My research builds on studies on fashion design as a profession and practice, and analyses recent digital practice through the lens of sociology of professions, authorship theories and the posthumanist "cyborg" ontology.

2.1 Ontological and epistemological positioning

This study plurally combines (see Figure 3) both pragmatism and interpretivism, critical realism and social constructionism, in line with extended epistemology and technofeminism, whereby bodies, matter and discourse are entangled, and the subject and object are in ontological symmetry (Rasmussen 2014; Britton, Klumbyde and Draude 2019; Haraway 1985). I attempt to converge fashion design as a situated and embodied practice with the recent technological reality.

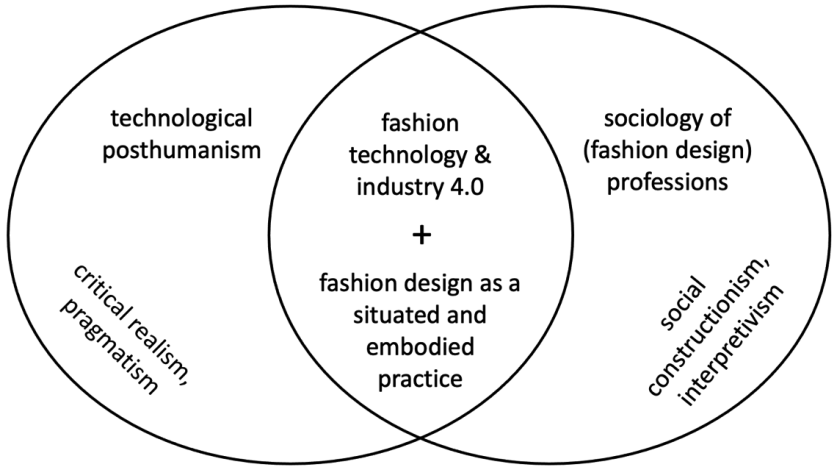

Figure 3. Ontological and epistemological approach. Design: Natalia Särmäkari.

Fashion studies and design research are relatively young disciplines, characterised by interdisciplinarity, multidisciplinarity and epistemological fluidity (Jenss 2016; Rasmussen 2014). The ontological and epistemological positioning depends on the disciplines from which a particular research project draws (ibid.). Epistemological freedom, fluidity and insecurity are typical for scientific inquiry that is acknowledged to be value-laden and contextual, where knowledges are situated and methodologies are hybrid (Longino 1990; Britton et al. 2019; Haraway 1988). For Helen Longino (1990, 67), scientific inquiry is a social, not individual, enterprise. I approach fashion practice and fashion studies as similar collective enterprises, assemblages of social negotiations, circumstances and cultural values, and a combination of theory and practice.

Due to its commercial and artistic dimension, fashion has long traditions in individualist myths (e.g. Barthes 1990 [1967]; McRobbie 1998; Kawamura 2018; Crane 2019). New technologies, practices, players and fashions are adopted in the field when the dominant fashion discourse "accepts" them. However, the world has changed profoundly. Where previously everything – including design work – was about social interactions, interpretations and discourses, today communication increasingly involves data. There is less room for interpretation in digital data-driven cultures, and communication might even happen between machines. After I started to collect empirical data in 2018, I found I had to diversify the epistemological approach and include posthumanism as a way of knowing (e.g. Haraway 1988; Smelik 2021; Vänskä 2018). Digital fashion design decentres the individual designer in collaboration with non-professionals, computers and data, and often creates non-human or posthuman aesthetics for spaces and bodies that blur the boundaries between organic and artificial. Decentralisation and deconstruction can be seen in both technological development and digitalisation, as well as in post-industrial and digital fashion practices and as the "fashions" of philosophy and science. The relationship between fashion, technology and other circumstances is relative, random, fluid and convergent: the history of fashion is also a history of technology, philosophy, ideologies, politics, society, economy, religion, art, design, everyday lives and so on (e.g. Quinn 2002; Lewis 2013; Tortora 2015; Vänskä 2018; Buckley and Clark 2018). Call them paradigm changes, zeitgeist, fashions or cyborgs (Haraway 1985), they are formed by everything around humans, as assemblages of particular moments in times, spaces and places. The philosophy of science is not detached from the everyday world and has not only reacted to its own history but has also been heavily impacted by the way the world works and transforms technologically, economically, culturally and societally at particular times. For example, now that philosophical discourse is often politically explicit (Haraway 1988; Simandan 2019), so is fashion.

Fashion actively changes the ways in which people think and behave. For example, in 1947, the House of Christian Dior changed the notion of femininity and the role of postwar women with its narrow waists, sloping shoulders, floral prints and voluminous skirts (Okawa 2008). In the same way, designers have tried to diversify the notion of gender through the clothes they design and the imagery they produce (Crane 1999; Vänskä 2014). Designers design how human

and non-human lives are lived by creating certain kinds of affordances (Norman 1999; Davis and Chouinard 2017). Design can never be neutral because the role of designers is active. "Design thinking" as a logic of solving problems is applied in almost any area or discipline (Lawson 2005; Nixon and Blakley 2012; Pan et al. 2015; Petersen, Mackinney-Valentin and Melchior 2016; Chun 2018; Dieffenbacher 2020). Having the notion of design thinking as their starting point, Nixon and Blakley (2012, 153) defined "fashion thinking" as "a paradigm of critical thought and creative agency utilizing technology, story, experimentation, and open-sourcing in order to add meaning and value to the functional and experiential spheres of products and services."

As a way of thinking, fashion can be considered an *epistemology and a methodology in itself*, as its situated, ephemeral, flexible, modular and temporal dimension is a material and visual representation of time and place (Nixon and Blakley 2012; Aspers and Godart 2013; Pecorari 2016; Petersen et al. 2016; Buckley and Clark 2018). Thus, fashion thinking can be a tool for analysing sociocultural processes (Petersen et al. 2016). Annamari Vänskä (2018, 18) suggests that fashion should be understood as "a form of knowledge production" that is more than material production of consumable commodities and provides tools for critical thinking. Though fashion typically materialises in clothes, which we should treat as "active and vibrant agents" that mediate and negotiate our notion of the human (ibid.), contemporary, conceptual fashion design sometimes goes beyond designing apparel (Clark 2012; Thiel 2017).

Fashion design as a professional practice has been little studied beyond (mostly Western and elite) fashion history and heroic (mostly male) designers (Skov and Melchior 2010). Many empirical studies have been conducted on fashion designers from the perspective of design research (e.g. Chun 2021, 2018; Bertola and Colombi 2021; Kauppi 2021; Aakko 2016, 2019; Ræbild 2015; Nixon and Blakley 2012; Finn 2014; Ruppert-Stroescu and Hawley 2014; Sinha 2002; Eckert and Stacey 2001; Lamb and Kallal 1992), ethnography (e.g. Huopalainen 2016; Vangkilde 2010; 2017) and sociology (e.g. Crane 1993; 1999; 2019; McRobbie 1998; 2002; 2015; 2016a; 2016b; Skov 2002; Kawamura 2004; 2018; Manlow 2007; Volonté 2012). From the viewpoint of the fashion design profession as a social structure, key scholars such as Angela McRobbie (1998; 2002; 2016a), Diana Crane (1993; 1999) and Yuniya Kawamura (2004; 2005/2018) draw on Pierre Bourdieu, Howard Becker and Michel Foucault to investigate designers in particular time and place. In such sociological studies, fashion design seems to be an *ontologically collective and methodologically individual practice* where designers balance between structure and agency (Baert 2005). I started from a similar perspective of the sociology of professions and Bourdieu's (1993a; 1993b) field theory. My research questions regard the possible professional transformations in the field of fashion design in the context of the contemporary technological landscape, characterised by smart digital tools, data-intensive platforms and decentralised systems (Bertola and Teunissen 2018). Thus, I am investigating a social phenomenon – fashion designers in their professional field, in flux at a particular time in history.

2.2 Contexts of the research

The main contexts of this research are the contemporary technological environments of fashion 4.0, the authorial-professional figure of the fashion designer underlying the social structures, professional jurisdiction, skills and embodied knowledge of fashion design, as well as the discourse of technological posthumanism in contemporary fashion culture.

2.2.1 Fashion 4.0

The fashion designer's profession, as we understand it, emerged during the industrial revolution and has since been shaped by further technological development and institutional legitimisation (Kawamura 2018; Manlow 2007). The key context of this thesis is the sociotechnical transformations associated with the recent *fourth industrial revolution* or *Industry 4.0* (Schwab 2016). Coined by the German government in 2011, the term Industry 4.0 first stood for smart factories but later evolved to encompass the whole digitising and datafying ecosystem of production, consumption, operations, networks, technology and products (Bertola and Teunissen 2018, 353). My hypothesis is that Industry 4.0's smart technologies, networks, and cyber-physical spaces directly affect fashion designers' professional jurisdiction and design processes. Industry 4.0 is argued to be characterised by six design principles: interoperability, decentralisation, virtualisation, real-time capability, modularity and service orientation (Hermann, Pentek and Otto 2016) and the concept of the digital twin – a digital data representation of physical systems, objects and bodies (Pires et al. 2019). Industry 4.0 offers "digital products and services, operating connected physical and virtual assets, transforming and integrating all operations and internal activities, building partnerships, and optimising customer-facing activities" (Geissbauer et al. 2018, 5).

Bertola and Teunissen (2018) argue that, compared to other industries, the fashion industry adopts new technologies slowly. However, they optimistically see fashion 4.0 as shaping fashion businesses in a more sustainable and customer-driven direction. This thesis does not take a stance or provide evidence on the positive or negative implications of fashion 4.0. Nevertheless, I acknowledge that the idea of Industry 4.0 is fostered by business consultants and political actors, who promote the term both as a solution to contemporary problems and a means to achieve neoliberal goals in capitalist societies. The reality is more complex than these "often dramatic narratives" (Hardy 2020, 106) that seek technological solutions to extremely complicated problems, rooted in the growth imperatives of capitalism. In this respect, the term Industry 4.0 is techno-utopian and dismisses the problematic aspects of, for example, the unprecedented authority of algorithms, datafication and the power division between the developers and users of software (see Rocamora 2022, 14–15). Fashion 4.0 possibly fuels the growth of technology conglomerates, such as Amazon and Meta, increasing the risk of small companies being bought and their creative autonomy being destroyed. Such risks should be examined carefully in future studies. I chose to use the concept of fashion 4.0 as a context

because it performs the role of the latest phase of industrialisation – closely connected to the profession of designers – and incorporates the characteristics of the current technological environments as well as their organizational, cultural and ontological qualities.

Fashion 4.0 is characterised by the rapid development of digital tools, cyber-physical spaces, the Internet of Things, robotisation, localisation, personalisation, and digitalisation of fashion heritage (Bertola and Teunissen 2018; Noris et al. 2021; Nobile et al. 2021). Several scholars have discussed the concept of fashion 4.0 (Bertola and Teunissen 2018; Behr 2018) and the implications of Industry 4.0 on the fashion industry (Grieco et al. 2017; de Haro and Wang 2021; Spahiu et al. 2021; Oesterreich, Schuir and Teuteberg 2020; Mosca and La Rosa 2019; Wang and Ha-Brookshire 2018; Braglia, Marrazzini, Padellini and Rinaldi 2021). Most of the articles focus on supply chain management and novel digital tools for these purposes. Oliver Behr (2018) uses the term fashion 4.0 without further conceptualisation in their article on smart clothing and wearables as new product types and business opportunities. Fashion and design scholars Paola Bertola and José Teunissen (2018) provide a deeper conceptualisation of fashion 4.0, a framework for Industry 4.0 and an analysis on the impacts of the fourth industrial revolution on the fashion and textile industry. Bertola and Teunissen's notion of fashion 4.0's "smart factories" ties the qualities of Industry 4.0 with the fashion system and design; therefore, it is the most relevant way to contextualise this research. "Smart factories" are complex, design-driven ecosystems where digital technologies enable globally interconnected networks of actors, assets, stakeholders, producers, retailers, consumers and machines. Users' demands can inform decisions in real time (cf. Hermann et al. 2016; Bertola and Teunissen 2018, 354). While digital manufacturing enables on-site production, digital platforms facilitate co-working, interaction and knowledge-sharing between different professionals, companies and users.

Fashion 4.0 entails robotisation, data-driven design, digitally enhanced processes, virtual 3D spaces, platform interoperability and complex cyber-physical systems (Schwab 2016; Liao, Deschamps, de Freitas Rocha Loures and Pierin Ramos 2017; Behr 2018; Wang and Ha-Brookshire 2018; Spahiu et al. 2021). The technological nature of fashion 4.0 is what Rosenberger and Verbeek (2015, 20–22) call *cyborg relations*. The boundaries between technologies and the environment, and between technologies and human bodies are blurred in such relations. A simple example of such relations is a smart ring that measures human body temperature. However, the use of digital 3D fashion design software also blurs the bodily experience of wearing clothes with a numerical representation of material and its behaviour on the body. Cyborg relations and cyber-physical systems can also be called *phygital* – a neologism synthesising physical and digital, the real and the simulated in the hyperconnected world (Gaggioli 2017). Introduced by the Australian agency Momentum in 2013, it is mainly used in marketing to describe omnichannel experiences (Van Tichelen 2019). In the field of digital fashion, however, the concept has gained popularity, referring to experiences and products that merge digital and physical in some

way, be it a digital-only garment as an AR experience, a physical garment in a virtual fashion show or the feeling of tactility in a virtual textile. For Bertola and Teunissen (2018), fashion 4.0 entails smart technologies, networks and products, and the convergence of the physical and the digital (Bertola and Teunissen 2018). Fashion 4.0's co-existing material and virtual dimensions are all related to fashion designers' work (see Figure 4). From the fashion design perspective, the most relevant technologies are virtual 3D tools and spaces, platforms and generative artificial intelligence.

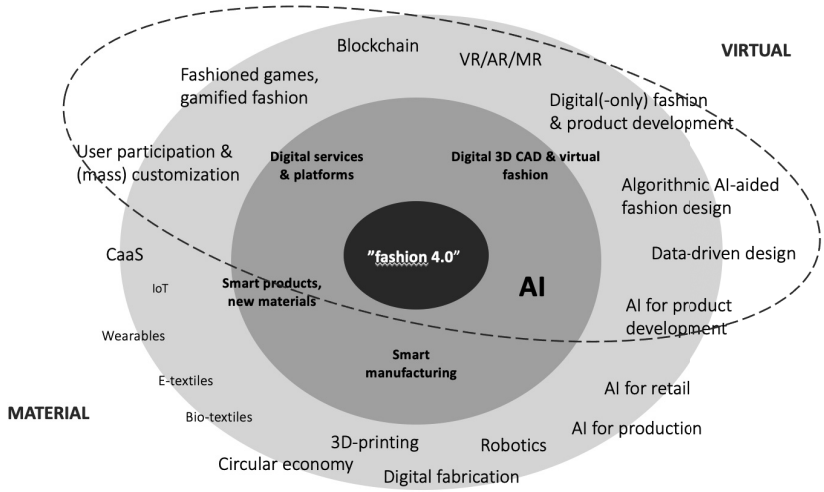

Figure 4. Fashion 4.0 technologies. The circled technologies contest the professional and authorial role of fashion designers. Design: Natalia Särmäkari.

Recent fashion technology research is dominated by the physical applications of manufacturing, such as 3D knitting, 3D printing, digital printing, laser-cutting, textile innovations, technologies that contribute to increased sustainability (e.g. Lee 2005; Sun and Zhao 2017; Black 2019; Karell 2021); co-design and mass customisation (e.g. Piller et al. 2003; Wu 2010; Smith, Blair and Cooper 2012; Peterson 2016); as well as datafied materialities and technologies that are incorporated in garments as embedded electronics, smart clothing, accessories in the form of wearable technologies and the Internet of Things (e.g. Quinn 2002; 2012; Seymour 2008; Braddock Clarke and Harris 2012; Atkinson 2017; Smelik 2018; van Dongen 2019). Concerning design and in the area of fashion studies and design research, literature on fashion technology has focused on the role of technology as a material, tool and conceptual approach in fashion design and questions of embodiment (e.g. van Dongen 2019; Braddock Clarke and Harris 2012; Seymour 2008; Smelik 2018; Volino, Cordier and Magnenat-Thalmann 2005; Quinn 2002; Genova and Moriwaki 2016; Förster 2018; Petreca 2017; Atkinson 2017). Experiments have been conducted in research, multidisciplinary design and the high fashion context, showing that technology is not only instrumental but also a source of inspiration for fashion designers, such as Hussein Chalayan, who incorporated wearable technology, image

projections and laser beams into his shows (Tortora 2015, 224; Quinn 2012, 42). Though wearable technologies require interdisciplinary collaboration and new skills, the design process is similar to any other design process of functional apparel or innovative technological products (Seymour 2009). Therefore, I have excluded the investigation of wearable technology design from my doctoral research, which focuses on technologies that tackle authorial and professional questions.

This study builds on the premise of digitally decentralised and professionally fluid fashion and post-industrial design (von Busch 2008; Crewe 2013; 2017; Rocamora 2011; 2016; Bendoni 2017; Sun and Zhao 2018; Hermans 2015; Hunt 2005). The concept of *post-industrial design* (Hunt 2005; Hermans 2015) draws from the sociological concept of *post-industrial society* (Bell 1973). In a post-industrial society, service and knowledge have become more substantial than manufacturing, structures more democratic and values more immaterial (ibid.). The organisational, social, cultural, economic and political changes that have been taking place since around the 1960s have been characterised as the "Information Age" and the "network society" (Castells 2010), "knowledge economy" and "experience economy" (Pine and Gilmore 1998). These developments imply that with the introduction of electronic communication technologies, the structures and processes have become more distributed and decentralised, and thus network-based (Castells 2010). Communication networks operate in the spaces of flows enabled by technological infrastructures, digitalisation and automation. Information is the key capital in the globalised knowledge economy that has witnessed the decline of blue-collar work (ibid.). The feedback loops that start with the introduction of technologies and pass through their use, going back to the development of the technologies, have become fast in the digitalised world (Castells 2010, 31).

In the service, information or knowledge economy, the role of universities has also grown, and this has involved the academisation of design universities worldwide (Cross 1982; Julier 2008). From the perspective of authorship and professionalism, the design field has also experienced another shift fuelled by digital culture and the intellectualisation of design (Julier 2008; Valtonen 2007). The designer has become a facilitator of the design process, opening their "black box" of knowledge for the public to evaluate and influence (Puustinen 2006, 185; cf. Schön 1991[1983]). In recent decades, the customer and user have become central, and this shift has transformed and expanded what we understand as design (Valtonen 2007). This is manifested in relatively novel human-centred design practices: user experience (UX) design, interaction design, participatory design, co-design, meta-design, open design and mass-customisation (von Hippel 2005; Sanders and Stappers 2014; van Abel, Klaassen, Evers and Troxler 2011; Fuad-Luke 2009; Valtonen 2007; Pine 1993). Guido Hermans (2015) draws a connection between the post-industrial society, technology and "opening up" design. Rapid manufacturing, algorithmic methods, and digital design enable participation and design initiatives for laypeople. As Hermans (2015, 304) argues:

> The role of the professional designer changes in a practical way in that the tasks are changing, different skills, tools and knowledge are required, and a different mindset is needed. The professional designer is no longer developing an end-use product, but he/she takes on the role of designing a toolkit that enables the layperson to design for one's context.

In fashion practice, digital manufacturing and computerised knitting enable similar activities. An early example of lay participation and customisation practices is the famous clothing system A-POC (2000) by Issey Miyake, who is passionate about technology (Braddock Clarke and Harris 2012, 94–95). In this system, a thread enters a computerised machine and a finished, customisable garment comes out, which "proposes a radical rethink of fashion manufacture for the twenty-first century" (Lee 2005, 29). Such a system also urges a rethink of the authorship of the designer, who actually designs the protocol of design that encourages collective creativity and lay participation. Miyake's A-POC is a predecessor of the so-called "3D knitting" machines that offer an alternative to traditional cut-and-sew production (Lee 2005, 28). 3D knitting refers to rapid digital manufacturing where the machine, such as the Japanese Shima-Seiki, produces unique knitted pieces without material waste (Peterson, Larsson, Karlsson and Andersson 2008; Peterson, Larsson, Mujanovic and Mattila 2011; Peterson 2016).

Other rapid digital manufacturing technologies besides 3D knitting, such as laser-cutting and digital printing, have also been used, mainly in a commercial context (Tortora 2015, 225). In contrast, 3D printing has seemingly been less successful in the fashion context, despite having been mentioned as a possible disruptor of the fashion industry, as it made it possible for the designer, maker and user to be one and the same person (e.g. Sun and Zhao 2017; 2018). Rapid manufacturing technologies are associated with fashion 4.0 as enablers of flexible, decentralised, modular, real-time production that can be connected to interoperable and virtual design tools (cf. Hermann, Pentek and Otto 2016). Digital manufacturing concerns practices that produce physical garments. For example, one of the case studies, Matti Liimatainen, built a laser cutter to produce garment panels. It can cut the highly complex seams developed by Liimatainen, for which he created generative algorithms that can draw complex structures (see Publications II and IV).

Paradoxically, regardless of the plethora of experimentation with technologies and the global fashion industry's global economic significance, the fashion system and fashion design practices are conservative in their operations and technological applications (Black 2019, 113; Atkinson 2017, 150). Computer-aided design (CAD) and automated, computer-aided manufacturing (CAM) enabled efficient international collaboration (Tortora 2015, 204–5). Communication technologies – the Internet and especially Web 2.0 – have significantly affected the fashion industry and its professional structures. Web 2.0 refers to the technological shift produced when user-generated content, online communities and virtual worlds with personal, dressed interactive digital bodies and avatars appeared in the late 1990s (Rocamora 2011; 2013; 2017; Bendoni 2017; Shinkle 2013; Kawamura 2018; Watstein and Czarnecki 2010,

276; Tortora 2015, 200; Torregrosa Puig, Serrano-Puche and Sánchez-Blanco 2021).

At the beginning of the 2000s, Web 2.0 enabled non-professional fashionistas and basically anyone to build their own identities, diffuse their fashions and share content (Leadbeater 2009; Rocamora 2011; Crewe 2013; 2017; Bendoni 2017; Choufan 2021). Authority and voice have increasingly shifted from the professional fashion system to communities and users (Shoemaker and Vos 2009; Kawamura 2018, 117). Wendy Bendoni (2017) argues that social media has disrupted, democratised and transformed the business models, management, marketing and design of fashion. When anyone has access to fashion imagery and the possibility to comment, share, and alter anything that brands show and sell, consumers will directly influence what designers create. Furthermore, working for screens has *mediatised* fashion design (Rocamora 2017). In mediatised fashion practices, the production, consumption, distribution, and diffusion of fashion are shaped increasingly by, for and through digital media (ibid., 509). For example, the streaming of fashion shows and online retail spaces has forced designers to make clothes, collections and events look "instagrammable" and tempting onscreen (Rocamora 2017, 511; Torregrosa Puig et al. 2021; Mendes 2021).

Concentrating on media attention rather than on how clothes look and feel in physical showrooms and stores, and on bodies has arguably had an eroding effect on craftsmanship and three-dimensionality (Atkinson 2017). Mediatisation went further in the contemporary Web 3.0 environment as part of Industry 4.0, enabled by AI applications and big data. In Web 3.0, digital content is datafied and interoperable between different digital platforms and devices, informing designers through various methods of data collection and analysis (see Publication IV, also, Rocamora 2021). According to Rocamora (2021; 2022), datafication has already resulted in the *deep mediatisation* of fashion among fashion influencers. This means that the influencers' creative output is steered by the data provided by the digital platforms because the influencers' social capital and numerically proven authority can be turned directly into economic capital (Rocamora 2022, 11). Various practices are datafied and quantified – turned into quantitative data – making algorithms active agents and players in the field of fashion (ibid., 16). As data-driven optimisation of products in any creative industry has shown, datafication of fashion design might result in generic and boring yet excessive designs (e.g. Sherman 2021; Härkönen 2021). With the increasing authority of algorithms and data, fashion designers may lose the element of embodied experimentation (see Publication IV).

Further technology-inflicted deterioration of fashion designers' garment construction knowledge was caused by outsourcing and offshoring – likewise a product of the information age and the fragmented post-industrial supply chain (Atkinson 2017). When design and marketing happen far away from manufacturing locations, designers do not participate as intimately in production. I find this a relevant contrast to fashion 4.0, in which design and making converge (Sun and Zhao 2018). Lushan Sun and Li Zhao (2018) have

studied the dynamics between makers, designers and users[6] in contemporary mainstream fashion worlds through focus groups with fashion professionals and academics, and reassessed professionals' roles in the interactive and circular supply chain network. Their findings suggest that the roles of makers, designers and users are increasingly intertwined: fashion designers have to learn how to communicate with technicians and engineers and how to code and develop technologies. Digital fashion simultaneously intensifies and juxtaposes the post-industrial implications; on the one hand, it is increasingly immaterial, while on the other, it brings design and maker closer to each other because both digital 3D and algorithmic design require advanced garment construction skills and digital craftsmanship (see Publications III and IV).

Lately, further virtualisation has happened with the phenomenon of digital 3D fashion (usually simply called *digital fashion*). This means that shows, artefacts and bodies are no longer physically mediatised for and by digital media but also *created in and by digital tools, for digital spaces and bodies, and are themselves digital.* Digital fashion is a tool and an entirely new fashion culture that has drawn increasing attention during the last three years (e.g. Milne 2019; McDowell 2020; BoF and McKinsey 2021). I see several reasons for the "rise of digital fashion". First, the mediatisation of fashion and emergence of immersive social virtual environments (nowadays in Web 3.0), which taught us to use screens as "technologies of the self" that shape the performative and embodied self either in social media, games or virtual reality platforms (cf. Foucault 1988; Rocamora 2011, 410; Rocamora 2017, 516; Shinkle 2013; Makryniotis 2018; Watstein and Czarnecki 2010). Second, the rapid development of designer-friendly software, enabled by smart technologies, computer power and artificial intelligence (see Publication III, also Nataliya.ai 2019). Furthermore, sustainability efforts pushed companies to experiment with digital fashion that promised reversed, on-demand business models (see Publications II and III; also, Black 2019).

Moreover, of course, the sudden appearance of COVID-19 forced the fashion industry to go through a rapid digital transformation (e.g. BoF and McKinsey 2020b). Fashion 4.0 differs from the platform-based fashion of Web 2.0 in terms of datafication (van Dijck 2014; Mayer-Schönberger and Cukier 2013; Rocamora 2021) and phygitality of spaces, tools, processes, products and designers (Gaggioli 2017; Schwab 2016). Here, datafication goes beyond the collection and use of data as it happens in the platform-based Web 2.0, to everything and everyone *becoming data*. Every physical object, organism, and digital asset starts having a digital data twin, moving interoperably between platforms and spaces. The possibilities of artificial intelligence are manifold: many researchers and companies have explored how big data and AI could assist and inform design, production and retail (Luce 2019).

Writing about fashion design processes that utilise AI and automation, I use the term *algorithmic fashion*. Here not only laypeople are involved in the

[6] By "makers", they refer to fibre, yarn and fabric production, whereas "designers" are the ones who design and develop garments; thus, Sun and Zhao see them as part of the clothing manufacturing system in the traditional fashion supply chain.

creation of fashion but also non-humans (computers) and data on countless people. Fashion 4.0 could be seen as another layer on top of the existing, already networked and multilayered fashion system, shaken by social media and e-commerce. The conventional fashion spaces "compete, coexist and coalesce with digitally mediated spaces", forming relational networks and blurring boundaries between the real and the virtual, material and intangible, production and consumption, professionals and amateurs, object and image, and online and offline practices (Crewe 2017, 129–130). Fashion 4.0 is more than post-industrial design. It is a network of pre-industrial, industrial, non-industrial and post-industrial players (see Hermans 2015, 51).

2.2.2 Authorship and profession of the fashion designer

Digital fashion designers are typically frustrated, disappointed and bored with the conventional fashion world. As one of the designers pointed out during my fieldwork in 2019:

> They [the fashion industry] have like a really toxic culture, it's the worst, they're really secretive, stab each other in the back. And everybody is just trying to get a piece out of the competitive industry. I don't care so much, and that's why we're like, we're not in the fashion industry, we're on the outskirts of the fashion industry.[7]

So, what do they mean by the "toxicity" of the fashion world? Closedness and competition are one dimension. Secrecy surrounds good manufacturing deals among designers (McRobbie 1998, 117–8), as well as new collections and ideas. The same goal unites all the cases I have studied: they are driven by the desire to turn the "toxic" fashion world on its head. They want to serve as an inspiring example, a proof of concept, even, and to show that a different fashion practice culture is possible. By now, we are all aware of the environmental impact and the severe exploitation of the workforce in the global South (e.g. Hoskins 2014). However, the immaterial labour of the fashion industry, including designers, is also infiltrated with inequality, exploitation, financial struggles, insecurity and an overall burnout culture. Empirical studies have demystified the glorified image of the fashion design profession and showed the reality of neoliberal, gendered and precarious work (McRobbie 1998; 2016a; Mensitieri 2013).

Angela McRobbie's (1998) seminal study on the work and profession of British fashion designers resonates with my experiences, and probably those of most fashion designers – British or otherwise. McRobbie's study provides a solid context for understanding precisely what digital fashion designers are fighting against on the level of professional culture. According to McRobbie, the reality of British fashion designers' professional lives after fashion school entails constant financial struggles. Even internationally praised designers run a high risk of bankruptcy and severe self-exploitation, accepting as a norm long working hours with low or even non-existent salaries and supporting

[7] While in 2019 they felt that they were at "the outskirts of the fashion industry", they have now become central players in the fashion industry.

themselves with other jobs (McRobbie 1998, 68). As Amber Jae Slooten (interview, 19 November 2019) from The Fabricant recalled, concerning her transition to digital during her fashion school studies: "I was working day and night and through the nights, always like not sleeping, just sewing. And it's horrifying. Until I realised that all of that could be done digitally." Also: "I worked in restaurants for a long time just to be able to… I didn't want to work in a traditional fashion job because it didn't feel like it matched my beliefs. So, I decided not to do that because I knew I would be drawn by it."

Social security systems vary depending on the country, and yet fashion designers across Europe tend to share a harsh beginning to their career, being either exploited by companies or unable to find employment, or having trouble compromising on their values (McRobbie 2016a; Kauppi 2021; cf. McRobbie 1998; 74–75). Some designers establish their "own label", leading an artist's lifestyle with irregular earnings and working conditions (McRobbie 1998, 81–82). Some have to transgress against their values and use unpaid interns or poorly paid workers because they cannot afford to pay decent salaries while not earning anything themselves (McRobbie 1998, 117–8). Even later in their careers, fashion designers might have to choose between having children and maintaining artistic integrity. Class correlates highly with survival, as those from wealthy backgrounds have a better ability to work for free or run unprofitable businesses (McRobbie 1998, 79; Bourdieu's 1993a, 68). McRobbie (1998, 32) argues that the artist myth has marginalised women and discouraged working-class people from pursuing design careers, affecting the professional identity of fashion design. At school (McRobbie 1998, 39–41) and through late neoliberal discourse, designers assume the entrepreneurial ethos of affective passion-work (cf. Ahmed 2004) and the idea of the self-sacrificing artist.

Fashion designers' authorship and hierarchies

Fashion design sought professionalisation by being placed in *art schools* rather than *craft schools*, establishing a higher status of "creative individuals" compared to unglamorous material manufacturing labour (McRobbie 1998, 38–39, 52–53). McRobbie connects the processes of professionalisation with a notion of the individualised author-subject, drawing on Foucault's essay *What is an Author?* (1994 [1969]). In that essay, Foucault asks in what kind of "system of valorisation the author was involved, at what point we began to recount the lives of authors rather than heroes," arguing that the author is an *ideological product,* "a certain functional principle by which, in our culture, one limits, excludes, and chooses" (Foucault, 1998 [1969], 221). Foucault calls this functional principle the *author-function*, referring to a contextual role of authorship, defined by specific discourses. I borrow Foucault's term to reflect on the novel author-functions that the contemporary digital fashion designers try to construct, bringing designers back from the eccentric individual to a collective player.

Authorship as a concept refers to the source of a piece or an act of writing, creating or causing (Merriam-Webster 2021). Etymologically, "author" is related to the Latin *auctor* (a person who invents or causes something) and *augere* (to increase, originate or promote), as well as to "authority" and

"authenticity" (Oxford Languages 2021; see Publication I). The Modern notion of an author or artist as a creative individual emerged after the invention of the printing press and during industrialisation (Woodmansee 1994). Copyright law inherited (or originated?) the Romantic notion of authorship where creativity is ascribed to a particular individual (Shiner 2001; Woodmansee 1994; Teilmann-Lock 2012, 34). The reproducible work of art or piece of writing had to be localised to a person with an authorial "aura" (Benjamin 2007 [1935]; Foucault 1998 [1969]). The notion of "art for art's sake" gained ground with the emergence of the Modern system of art in the 18th century and later, during Romanticism (Shiner 2001; Kristeller 1951; Benjamin 2007 [1935]; Bennett 2005).

Similarly, the notion of the single designer is linked to industrialisation because exclusive dress had to be "distinguished from the vulgar [mass-produced] copy" and, therefore, the "designer had to become an Artist" (Wilson 2013 [1985], 32). Artistic autonomy and the status of the artist, *artification*, became the key legitimisation strategy for all designerly professions (e.g. Sciulli 2008, 11; Shapiro and Heinich 2012; Wiberg 1996; Aaltonen 2010; Hermans 2015, 270; see Publication I), especially in fashion, where designers praised by the fashion system personify clothes (Mora 2006; Kawamura 2018, 65). In other words, authorship and creativity are a social construct and a social act of *authorisation* (see Publication I, Särmäkari 2020). According to Bourdieu (1993b, 65–66, 73) certain players in the cultural field and beyond receive authority through such authorisation by the legitimate system to which they belong, and within a certain set of rules (*doxa*) set by the preceding struggle for monopoly of the capital. As Bourdieu (1993b, 65) puts it: "[…] there has to be a relationship of authority and belief, a relation between an authorised emitter and a receiver ready to receive […]" in a legitimate situation, using legitimate language and having a legitimate habitus. The ones holding a monopoly over the capital tend to rely on strategies of conservation, whereas ones with little capital use subversive strategies (ibid., 73). The legitimate authority and the desirable capital are field-specific. Fashion designers' attempts to enter the field of high culture have earlier urged the authorised players of the art world to defend the capital of high culture (ibid.). However, within the professional field of fashion, authorised artist-designers arguably dominate the symbolic, cultural and social – or *fashion* capital – of their field.

The Romantic author-function is a crucial *professional legitimisation strategy* and stratification determiner in the traditional field of fashion design, and creative freedom is also one of the main goals of digital fashion designers (see Publication III, Särmäkari 2021a). Couturiers (often male) and independent designers have long promoted their commercial disinterestedness and artistic integrity (McRobbie 1998; Bourdieu 1993a; 1980), positioning themselves against the commercial and crafty practices of (often female) designers (McRobbie 1998, 43; cf. Aaltonen 2010; Konttinen 1993; Shiner 2001). The implicitly necessary technical and business skills were, instead, de-emphasised (McRobbie 1998, 48). This tendency is subverted by digital fashion designers, who highlight their technical skills, garment construction knowledge

and "digital craftsmanship" (see Publications II-IV). As discussed in Publication I, there is a cultural and social *hierarchy* between artistic and mass fashion, both having very different authorial roles of the designer. The socio-economic privilege only reaches a fraction of fashion designers, and those who attain personal recognition tend to construct the status of the entire profession (Manlow 2007, 93).

The key moment for the institutionalisation and professionalisation of fashion design, as part of the emergence of the modern European fashion system, was after the decline of the guild systems and the societal changes generated by the French Revolution (Kawamura 2004, 35). In 1868, the predecessor of *La Fédération Française de la Couture, du Prêt-à-Porter des Couturiers et des Créateurs de Mode* (The French Federation of Couture and Prêt-à-Porter for Couturiers and Creators of Fashion) was established by the "father of haute couture," the Paris-based British couturier Charles Frederick Worth (ibid., 36–38), who opened his atelier, *House of Worth*, in 1858. In fashion history literature, Worth is considered the first fashion designer who shifted the power from the clients to the couturier (Steele 2017; Breward 2003; Pouillard 2017). Worth introduced the first label in the history of fashion, having the designer's signature on the tags (Crane 2012, 105). Pierre Bourdieu (1993b; also Bourdieu and Delsaut 1975) drew a parallel between *haute couture* and *haute culture* (high culture), a field of restricted production dominated by "art for art's sake" values, whereas the mass market was a field of large-scale production, dominated by commercial values (Bourdieu 1993a). It is debatable whether fashion – including haute couture – was ever considered *art proper*. However, the process of artification – not being art but reaching toward the principles of art (Naukkarinen 2012) – could be seen as a strategy of professionalisation, also typical for other applied arts professions.

In our current fashion system, haute couture has not lost its glow: for example, The Fabricant calls its practice "thought couture" and "digital couture" to position itself as a high-end *fashion house*.[8] Doeringer and Crean (2006) created a "fashion pyramid", where haute couture is at the top, followed by designer collections, bridge fashion, better fashions and fashion basics, with basic commodities at the bottom. This pyramid is one way to illustrate the value structure of the conventional field of fashion design. The higher the design context is positioned, the higher the authorial and professional status of the designers. On the lowest levels, designers are anonymous or even redundant. Accordingly, Kawamura (2004, 39-40) classified designers into elite *couturiers* and *créateurs* working with haute couture and high-end ready-to-wear, compared to *stylistes* working in mass-market companies. Diana Crane (1993; 1999; 2000), who studied the fashion design occupation in US, France, UK and Japan, argues that the fashion system was decentralised, and that in the 1960s

[8] See https://www.thefabricant.com/blog/2019/10/3/from-haute-couture-to-thought-couture [accessed 15 February 2022]

haute couture was replaced by luxury fashion, industrial fashion and street styles, making fashion forecasters important new players in the fashion field.[9]

Nowadays, there are many practices outside of the "fashion pyramid", such as experimental semi-entrepreneurs (McRobbie 2002), upcycling and other approaches drawing from circular, participatory and slow ideals (Fletcher 2008; Clark 2019; Karell 2021); academic research-through-design practices (e.g. Valle-Noronha 2019); as well as independent fashion micro-enterprises relying on or differentiating themselves through everything from digital technologies and artisanal methods to collaboration with local communities and autonomous creativity (see Fletcher 2008; McRobbie 2016a; Chun, Gurova and Niinimäki 2017; Black 2019; Aakko 2019). The fashion system has become an increasingly diverse field of practices, navigating through a world with major problems and accessible digital marketing tools. The professionalisation strategies of fashion designers also depend on specific cultural and geographical contexts (McRobbie 1998, 2015, 2016a, 2016b; Kawamura 2004; Crane 1993; 2000; 2019; Gronow 1997; Skov 2002; Volonté 2012). Fashion authority has spread from Paris and other "fashion capitals" (London, New York and Milan) to Asia, Russia and South America (Steele 2017; Gilbert 2012; Godart 2012) and now increasingly to the immersive *virtual space* (Watstein and Czarnecki 2010), which is becoming the new fashion hub, more independent from productional, social and cultural factors.

Digital fashion practices pursue the demystification of fashion authorities and want to ensure the dissolution of the fashion culture's authorial-professional hierarchy in the virtual space. For example, Jimmy Herdberg from Atacac explained that from a program developer's perspective, the protective attitude of the fashion industry is irrational because "it's super easy to copy a garment, so it's a stupid idea to not share it." Copying has always been normalised as a part of the fashion culture and industry (Okawa 2008; Paulins and Hillery 2009), fuelling fast-forward innovation but also secrecy (Raustiala and Sprigman 2006). According to fashion law scholars, the authorship of fashion designs is extremely difficult to define and copyright, due to the inseparable relationship between design aesthetics and the utilitarian element (Jimenez and Kolsun 2010; Teilmann-Lock 2012; Härkönen 2021, 7).

Design inspiration comes from innumerable influences and fashion products are rarely entirely new, always entailing a combination of novelty, functionality and familiarity (Paulins and Hillery 2009; Teilmann-Lock 2012, 41). Even artists are not as disinterested as the doxa (implicit rules and assumptions of the game) of their field suggests (Bourdieu 1993b, 140). Research on the everyday activities of fashion designers demystified the *auteur* and has shown that the work of designers is collaborative, networked and entangled (McRobbie 1998, 2016a; Kawamura 2018; Huopalainen 2016; Vangkilde 2010). The auteur has been discussed, contested and transformed in and by diverse humanities,

[9] Kawamura disagrees, arguing that forecasters collect their data mainly from fashion weeks. Based on my experience of browsing trend forecasting services such as WGSN and Stylesight, I disagree with Kawamura. Forecasts have long drawn from a myriad sources, including the street, arts and entertainment, and these days social media.

including aesthetics, art theory, film theory and literary studies (Bennett 2005; Burke 2008). Pointing to the author as a product of capitalist individualism, Barthes (1977 [1968], 143–146, 148) argued that we cannot know who speaks in a work because the language is the speaker, to which Foucault (1998[1969], 205) responded that it does matter who we *think* is speaking. The theoretical premise of the "death of the author" (Barthes 1977 [1968]) has moved beyond the scope of Barthes and Foucault, and the discussion should rather concern re-definitions, multiplication, plurality and hybridity, as well as the different roles and statuses of the author (Dobos 2008; Burke 2008; see Publication I).

The digital age has prompted vivid debates on the changing understandings of authorship. Open-source philosophies, networked digital collaboration and increasing utilisation of artificial intelligence are all challenging the nostalgic, singular notion of authorship and human agency (e.g. Picon 2019, 40). For example, in collaborative initiatives of open-source software development, the ideals of craftsmanship and a job well done *together* surpass individualism and competition (Sennett 2008, 24–27).[10] As I propose in Publication I, the author has become a layered network, hive, palimpsest, rhizome or mycelium where individuals are parts of collectives. Creative processes involve sampling, remixing, digital prototyping, and parametric design, resulting in limitless production of open-ended artefacts (van Abel et al. 2011; Bollier and Racine 2005). Authorship has been scrutinised and also redefined in "post-digital" artworks (Abrons 2019, Vierkant 2010; Kholeif 2018; Paul 2017) that critically reflect on a condition where the networked digital mindset and "the logic of algorithmic processing" is entangled with everyone's fleshy existence, merging digital and physical worlds (Openshaw 2015, 5). With the shift from fixed to networked media, the cultural distribution system has shifted from "one to many" to a collective "many to many", which has diminished the exclusivity of cultural production and turned cultural output into works-in-progress that anyone can build upon (Abrons 2019, 5; Vierkant 2010). However, this does not mean that the digital culture is actually democratic, either within or without open-source software communities. Especially in corporate contexts, new hierarchies and power structures may evolve, deeply embedded in capitalism and defined by the technology companies that develop software, manage data, quantify the value of creativity and fuel precarious working conditions (see Rocamora 2021; Hardy 2020). As Jane Hardy argues in her book on contemporary labour in Britain, regardless of the shifts in work culture and discourse on the "new economy" and "cool jobs", in the gaming industry there is a continuity of the oppression and exploitation that emanated at the dawn of capitalism (Hardy 2020, 54–55). Such exploitative practices may also apply to digital fashion designers, as precarious conditions already exist in both the fashion and gaming industries. Both in traditional and digital fashion contexts, the authority and authorship of fashion designers do not only have cultural or

[10] Sennett (2008, 25) also notes that the open-source software developers' community also grapples with poor quality when anyone can participate, and generates new hierarchies where the elite developers are above the mediocre developers.

legal meanings but are also tied to capital ownership, possibly endangered when open-source ideals are implemented.

As I state in all four articles, contemporary digital fashion designers have entered the conventional fashion system using subversive strategies, questioning its designer authority, secrecy, hierarchical structures and material production, and even its human-centricity. They are also predominantly legitimised by online communities, like-minded networks and media, and only lately by academia and the dominant fashion world (see Publications III and VI). Several case studies compared the current digitalisation and virtualisation of the fashion system to the digitalisation of fashion journalism at the beginning of the millennium. Agnès Rocamora (2016, 234–235) applied Bourdieu's field theory framework to analysing the tension between traditional fashion media and bloggers, and gave a good explanation for Bourdieu's *field*: a "microcosm structured by the power relations between forces of conservation and forces of transformation, and the state of these power relations at a particular historical time determines the structure of the field at that time". The players' *habitus*, formed by their social, symbolic, economic, cultural and embodied capital, defines their success in the game together with distinction strategies, used to gain status within the field and in relation to other fields (Bourdieu 1984; 1986; 1990).

Bourdieu (1993a) also writes about the *dominant leaders* and *newcomers* to the field. Revolutions are used to replace old leaders by contesting and redefining the doxa of the field. While British fashion design gained its global status and distinction from French traditions through reliance on popular culture, fashion media, a street market DIY ethos, and conceptual fashion education (McRobbie 1998), bloggers – or nowadays influencers – have legitimised their established position in fashion by differentiating themselves from traditional fashion professionals in highlighting their authenticity and independence (Rocamora 2016, 246). Blogger-influencers were the newcomers who challenged the values and practices of established players, showed that anyone can enter the fashion field (in theory) and also opened the doors virtually to their followers. Over the last two decades, bloggers and influencers have turned from revolutionary newcomers into an integral, commercialised, *authorised* and institutionally legitimised professional group of the dominant fashion industry. The earlier discussion on the democratisation of the fashion field has become less topical today with the exclusivity and professionalisation of influencers and content creators, who have formed a monopoly around their skills, services and personal brands, created firm relationships with companies and even founded trade unions (see Pedroni 2022). Furthermore, as Rocamora (2022, 20) argues, referring to the Bourdieusian account of authority, "the quest for the truth in data analytics" has become the influencer marketing companies' quest over authority in their field. Data is not only a tool for optimisation but also holds symbolic capital, becoming a performative function of seemingly neutral objectivity and a myth in which the field believes (ibid., 21; or "dataism" as proposed by van Dijck 2014) – similar to the Romantic myth of the author.

The changes in the power structures of the fashion field have also been discussed in relation to the profession of fashion design. Digital communication technologies have made the threshold for becoming a self-taught designer considerably lower, as anyone can market and sell their products via the internet. According to Kawamura (2012, 120–122), the occupational categories in fashion have been *de-professionalising* since the rise of subcultures and street fashion. Kawamura's account of de-professionalisation refers to the processes where fashion labour does not need to be formally trained or legitimised by institutions, such as fashion magazines, companies or organizations. In such processes, fashion designers are increasingly legitimised by social media, as also the gatekeeping system becomes decentralised and de-professionalised (see also Kawamura 2018, 116–119; Bendoni 2017). De-professionalisation is here a reverse process of professionalisation, where the professional entry barriers are set and a high social status for designers is pursued through institutional legitimisation and cultural capital (Bourdieu 1993b). De-professionalisation has been addressed in design studies and the sociology of professions as a more complex phenomenon, especially associated with the digital age, where professions lose their monopoly over certain tasks, as well as their status in society, their exclusive access to expertise, and their autonomy in controlling problems and practices (Toren 1975; Abbott 1988; Konttinen 1993; Saks 2012; Manzini 2015). Therefore, the boundaries between professionals and non-professionals – users, amateurs, practitioners of other professions and even computers – become blurred, typical for the recent "post-professional" era (Atkinson 2010, 138). De-professionalisation challenges the efforts of professionalisation and barriers that separate professionals from non-professionals through formal education, experience and institutional legitimisation.

Having direct contact with consumers through social media gives professional and non-professional designers equal possibilities to expand their clientele (Moore 2021). However, it is also difficult to stand out from a mass of designers promoting their work on social media. This aspect was raised by Atacac when their designer (6 March 2019) suspected that digital fashion designers are in the same situation as other creators using social media channels: anyone, anywhere can become a designer, but only few will gain success. In some cases, de-professionalisation means that the artistic and technical skills of designers become extinct and the traditional fashion world loses its authority. In design discourse, however, de-professionalisation refers to a purposive act of dissolving elitism, hierarchies, access barriers and the overall myth of the designer (e.g. Manzini 2015; von Busch 2008; Hermans 2015). Hence, de-professionalisation is something that *happens* to professions in certain changing societal and technological environments but, at the same time, it is also something that professions *actively bring about* in order to redefine the notion of authority and capital within the field.

De-professionalisation of the fashion world in digital fashion culture does not mean that the practitioners are becoming less skilled: on the contrary, the spectrum of skills expands (see Publications II–IV). According to the

informants of my study, the importance of higher education and formal degrees diminishes in digital fashion and instead there is a slow ladder to climb from internships to designer jobs. Having the right skills and digital culture attitude trumps a design education, as it is hard for schools to keep up with the pace of digital transformation. Similarly, authorisation is obtained not only from the fashion world but also from the fields of technology, games and entertainment, as well as online communities built around digital fashion practices. In this sense, digital fashion presumably accelerates the de-professionalisation of fashion, while simultaneously *re-professionalising* fashion design by redefining of authority and capital.

Fashion designers' skills and professional jurisdiction

What aspects of fashion design might be de-professionalised and re-professionalised? Re-professionalisation refers to a process whereby earlier attempts at professionalisation are restructured and the capital is redefined by the new players, gaining a more dominant position, and renegotiated with the old players. While, as I mentioned previously, it is debatable whether fashion design can be called a profession (an occupation with high social status) or merely an occupation, I intentionally label it as such, as even the whole notion of protectionism of professions is questionable (Abbott 1988; Sciulli 2012). Questionable or not, professional fields still try to elevate their societal position using various strategies – ethical, artistic and intellectual – contributing to the processes of professionalisation (Siegrist 2001; Konttinen 1993). Professions also pursue a mandate from their field, from neighbouring fields and from the public, related to performing and autonomously defining certain tasks. Andrew Abbott (1988) calls this mandate a professional *jurisdiction*, highlighting the importance of the actual expertise and everyday work of professionals.

In terms of expertise, the professional figure of fashion designers is nowadays complex, manifold and contextual (Volonté 2012; Crane 2012; 2019). Designers' tasks, aspirations and practices depend on the scale of the business, the market level and the industrial, cultural and educational environment (Aakko 2016, 34; Renfrew and Renfrew 2009; Sinha 2000; Volonté 2012). Designers need to meet a certain level of functional, aesthetic and economic qualities, but they also need to consider the temporal, bodily and discursive dimensions (Nixon and Blakley 2012; Dieffenbacher 2020). The work of fashion designers usually requires teamwork and commercial activity but also hands-on garment construction skills and embodied knowledge (Kawamura 2018, 62; McRobbie 1998, 83–87; Ræbild 2015; Huopalainen 2016).

According to Vangkilde (2017), the crucial role for a fashion designer is to apply both "totemism and animism", referring to what many scholars place at the core of fashion design: searching for a paradoxical blend of newness and continuity, creativity and branding, difference and conformity, homogeneity and heterogeneity and so on (Rupper-Stroescu and Hawley 2014; Bye and Sohn 2010; Eckert and Stacey 2001; Lamb and Kallal 1992; Nixon and Blackley 2012; Chun 2018; 2021; Hyun and Lee 2018). A fashion designer needs to be "a market researcher of visual and qualitative data, an analyst of the collected data, an interpreter of meanings and a negotiator in an expansive decision-making

process" (Sinha 2002, 4). McRobbie (1998, 29) argues that what made the work "fashion" was the way it positioned itself within a recognised tradition of fashion design, relying on the earlier designer(s) or challenging the traditions.

According to Kawamura (2018, 61), designers do not have a clear job description, nor are they required to have formal education. All the skills can be acquired through work experience and status through social acceptance. The term fashion designer usually refers to work consisting mostly of sketches or drawings, which are translated into a garment model, pattern and prototype, then to be revised and prepared for production (Tortora 2015; Manlow 2007). The fashion design process typically entails designer-driven hands-on activity, such as sketching, draping, handling the materials and fitting on human models, which requires technical skills, creativity, aesthetic and temporal sensitivity, and commercial considerations (Sinha 2002; Renfrew and Renfrew 2009; Bye and Sohn 2010; McKelvey and Munslow 2012; Nixon and Blakley 2012; Kawamura 2018). Fitting is essential at various stages of the design process, for the designer to assess the functionality, dimensions, appearance, draping, fall, feel, colour and structure of the material (Raebild 2015, 118, 131–134). McKelvey and Munslow (2012, 35) propose that the clothing design process comprises six phases: brief, research, design, development, production and distribution. Based on the brief and research, a concept is created, a collection structure outlined, choices and acquisition of garment materials conducted and, in some cases, patternmaking and cutting performed (Tortora 2015, 204).

In small businesses, the designer's role is typically integrated, autonomous and technically skilled, yet financially constrained (Aakko 2016; McRobbie 2016a). In bigger commercial companies – whether luxury or mass-market – designers' tasks are often more specialised, for instance to menswear, underwear, knitwear or outdoor garments (Renfrew and Renfrew 2009; McKelvey and Munslow 2012). Some designers make sketches, while others do not. Some have mastered draping and patternmaking (Rissanen 2007; Lindqvist 2015), whereas others focus on the concept, image and representation, or refrain from making physical garments entirely (Clark 2012; Atkinson 2017; Thiel 2017). Functional clothing designers focus on user research and meeting users' needs and desires, and their work is closer to the principles of "design thinking" than "fashion thinking" (Lawson 2005; Watkins and Dunne 2015; Nixon and Blackley 2012). Freelance designers' work is highly fragmented and requires a versatile toolbox, communication skills and international collaboration ability (Kauppi 2021).

Designers might be employed as managers of design departments, planners or product managers who are responsible for results, and their work may include tasks such as leading projects, allocating work, coordinating production and setting goals for collections (Sinha 2000; Hayes, McLoughlin and Fairclough 2012, 185–192). Designers may be creative directors, communicating meanings through concepts, fashion shows and images (Crane 2012, 100; Evans 2011; Clark 2012; Van de Peer 2014, 447; Entwistle 2009, 134). Some designers create clothes for the media, entertainment industry and brand image rather than for consumers (Rocamora 2017; cf. Baudrillard 1994).

Computers have also become an essential tool for designers to seek ideas, use digital photos and pictures, and sketch and draw instructions. CAD is typically used to compose mood boards and fashion products – flats/working drawings, specification sheets and style sheets (Sinclair 2014, 674–678) – but also for maintaining a digital design library, making digital presentations and creating a digital design portfolio (Sinclair 2014, 678–685). Digital fashion designers take this one step further and use CAD for product development, production, distribution and retail (see Publications II–IV).

Fashion designers' actual work, processes, dynamics, expertise and key skills form their professional jurisdiction (Abbott 1988), which differentiates them from other professionals and non-professionals. I use sociologist Andrew Abbott's (1988) concept of professional jurisdiction as one of my main analytical tools, linking my research to the tradition of the sociology of professions, which focuses on the position, structures and distinctive characteristics of professions. This framework is suitable for studying professional transformations because it helps one understand why people act in certain ways and in specific contexts rather than just describing their experiences (Valtonen 2007, 347).

Sociology of professions underwent several phases, affected by different scientific paradigms (Saks 2012; Konttinen 1993; Brante 2011; Kuhn 1996). The earliest was the functionalist approach (e.g. Parsons 1939), which typically measured professions against ideal characteristics: high education, autonomy, ethics, professional trade unions and an altruistic mission to serve society (Brante 1988). Functionalists were later criticised for their idealism, taxonomising, generalising, ahistoricity and narrow investigation of roles (e.g. Saks 2012, 2–5; Sciulli 2008, 5–6; Konttinen 1993, 8; Brante 1988, 122; Larson 1977). The second, Neo-Weberian phase drew from Max Weber's theory of *social closure*, according to which power is obtained through exclusion, meaning that a professional group establishes and maintains a *monopoly* of expertise to ensure privileges are scarcely distributed among its members (Saks 2012; Konttinen 1993, 8–9; Larson 1977, xvii). Neo-Weberians were interested in the *strategies of professionalisation* and the enabling conditions that prevail in society (ibid.). They were followed by third-wave professions sociologists, including Abbott (1988), who built on previous theories but focused on the contextual dynamics within and among professions (Konttinen 1993; Beckman 1990; Puustinen 2006, 77).

This thesis follows Abbott's emphasis on empirical research, the relationship between professions and work itself, and how the *content of work* constructs the professional jurisdiction that differentiates it from other fields (1988, 18–20). According to Abbott (1988, 87), jurisdiction gives the profession the right to define, dominate and solve certain societal tasks and problems. In attesting jurisdiction, the profession requests society to recognise its cognitive structure and its exclusive right to particular practices (ibid. 59). Subordinated professional groups, such as production and manufacturing in relation to designers, are vital for the professions to maintain their status (ibid. 71; Valtonen 2007, 36). The system of professions transforms under the influence of internal and external disturbances (Abbott 1988, 90–92). For example, in

industrial design, *internal disturbances* have appeared in the form of an increasing level of abstraction and design research (Valtonen 2007, 38). When *external disturbances* shake the system, new areas of jurisdiction open and close, and both old and new professions might be seeking new ground (Abbott 1988, 90). Abbott lists four external disturbances: technology, organisations, natural facts and cultural facts, from which technology and organisations create new professional tasks (ibid., 92). Disturbances can change, even destroy old jurisdictions. A group that has lost its jurisdiction may begin to compete for a new jurisdiction or strengthen the old areas of its former jurisdiction (ibid., 91). For example, developments in the electronics industry simultaneously affected graphic design and industrial design, merging them into one jurisdiction: Human-Computer Interaction (HCI) (Valtonen 2007, 37).

Digital fashion is occurring simultaneously in fashion and game design, and together they might form a novel jurisdiction, that might be called "metafashion design".[11] Internal and external disturbances are at the core of my research, which looks at the de-professionalised and re-professionalised digital fashion design field, seeking new jurisdiction through intellectualisation, merging fashion with the world of technology and emphasising craft – the embodied knowledge of designers (Raebild 2015; Entwistle 2000a; 2000b; Publications III and IV).

Fashion design as an embodied practice

The body is at the core of all fashion practices (Ræbild 2015; Petreca 2017; Entwistle 2000a). Joanne Entwistle (2000a; 2000b) sees dress as a *situated bodily practice*, based on the fleshy and social existence of human bodies. Consequently, I see all types of fashion design as a situated and embodied practice. In fact, embodied qualities are highlighted by digital and algorithmic fashion designers (see Publications III and IV). For example, Matti Liimatainen analyses his own tacit knowledge and embodied experience as a designer and a human being, and turns it into algorithms that form a fashion design automation system. Atacac's designer always starts the design process with the body and develops digital 3D models in dialogue with physical fittings and kinetic bodies. Often, he tries on and moves around in the garments himself, and he wears only his own designs. He also uses a human-sized screen next to his CLO3D work "table" to ensure that his own experience of the garment is close to what it would be with a physical prototype.

> I'm the patternmaker, and I have always been. My design practice has always been as a patternmaker, so for me, I think, that's one reason why I so easily and happily adopted this [digital 3D design], because it's sort of suited the way I've always been working. Very nicely. I think if I were a designer who was not interested in patterns, then it would be harder to do that. (Rickard Lindqvist, 8 March 2019)

[11] Digital-only clothing retailer DressX calls digital 3D fashion "metafashion" and digital-only dress "metalooks", see https://dressx.com/ [accessed 15 February 2022]

Studies from the perspective of human-computer interaction have shown that virtual fashion experiences are embodied and affective (Schinkle 2013). Digital designers apply their lifelong fleshy and sociocultural knowledge (Entwistle 2000a), together with their hands-on professional tacit knowledge, to their fashion design practice, just as any other fashion designer does. Designers perform the art of "embodied-material bricolage" and an unfinished, hectic process of endless becoming (Huopalainen 2016, 7–9; von Busch 2008) in an affective economy (Ahmed 2004) with high demands but limited resources. Fashion design as a profession has certain similarities with other design and architecture professions (lately digitalised) that combine artistic, technical, economic and social dimensions (Larson 1977, 27; Puustinen 2006; Aaltonen 2010; Sparke 1983; Wiberg 1996; Valtonen 2007). The evolution of professions results from their interrelations, determined by how these groups control their knowledge and skills – the *techniques* and the *abstract knowledge* that informs the practical techniques (Abbott 1988, 8). Abstract knowledge can also refer to tacit artistic and creative skills (Puustinen 2006, 39; Brante 1988; Schön 1991[1983]).

Tacit knowledge (Polanyi 1969; 1998[1958]) is important in practical and techno-cultural professions, such as fashion design. It refers to the implicit and embodied knowledge learned through practice in action (Polanyi 1969), which is difficult or even impossible to teach verbally. An example is riding a bicycle. Drawing on Dewey and Polanyi, pragmatists highlight the role of action in addition to perception in relation to experience (Määttänen 2015, 74). The tacit meanings we bestow upon objects emerge with time through conscious reflection on and in action (practice) and unconscious *habits* that our bodies develop in action (ibid.; Schön 1991[1983]). Thus, various bodily experiences define our relationship with artefacts such as clothes and technological devices.

Ulla Ræbild (2015) took a socio-material approach to studying fashion design processes, seeing the body as the starting point for fashion design. According to Ræbild's (2015) ethnographic research on Danish fashion studios, designers utilise their own bodies and those of surrounding people in their design processes when examining drawings, making two- and three-dimensional patterns, "handling" materials and evaluating the end results through fittings of prototypes and samples. Designers use their bodies as "paper" for "indicative drawing" when they are communicating their thoughts about garment details and fittings (ibid. 120) to the team. In line with Polanyi's tacit knowledge concept and Schön's reflective practitioner concept, Ræbild argues that design methods evolve by merging thinking with doing and theory with practice, and designers cannot explicitly describe their work and processes. Therefore, it is also challenging to teach design methods to students without doing (ibid., 178, 183). Ræbild is not the only one to identify the extent to which the professional activity of designers is embodied and tacit. Whether at Vivienne Westwood (Thornquist 2005; Lindqvist 2015) or 2OR+BYYAT in Helsinki (Huopalainen 2016, 27), even auteur-driven fashion design is full of bodily vitality, kinetics, pragmatism and chaotic entanglements.

For Eckert and Stacey (2001), abstract thinking and concrete doing merge in fashion design, as do technical skills and a visuospatial memory of "clothing archives". The starting point for many designers are visually and haptically experienced mental schemes of clothing (Eckert and Stacey 2001, 4). Fashion designers are human bodies that have worn clothes since their birth and have experienced the social side of fashion for almost as long (Entwistle 2000a). A fashion designer can justify many of their choices through data and trend reports, but aesthetic choices such as the positioning of a seam or a particular thread shade are somewhat difficult to explain. The question of embodied knowledge becomes crucial in research on the use of artificial intelligence in fashion design processes (see Publication IV), but equally so in processes where the work of the fashion designer happens in the virtual space, "handling" virtual materials and "fitting" on virtual bodies (see Publication III). In both algorithmic and digital 3D design, the embodied tacit knowledge of the designer defines their expertise, the quality of their work and their position within the professional (digital fashion) community.

The bodily dimension also stretches to the designers' own bodies in the form of stress and its physical implications, derived from long hours, an intimate relationship with work, an entrepreneur's financial struggle or a low-paid entry-level job, or unemployment (McRobbie 1998; 2016a; Kauppi 2021). Designers could be seen to *embody* the values of their professional culture, including compromising their wellbeing in favour of artistic autonomy, engaging in competition and working for grands auteurs. This brings us back to the aspects of the fashion world that digital fashion designers consider "toxic" and wish to tackle by building a novel working culture and processes that could ease their burden. All of my cases chose the path of what I call *work sustainability*, meaning that they all considered central a feeling of togetherness and the fact that work should not cause burnouts. All of my informants emphasised that one of their main drivers in developing new fashion design culture was a healthy company culture, which respects their personal and family lives, inspires them to come to work every morning and serves as grounds for friendship rather than competition.

In summary, this thesis treats fashion design as a professional social practice with associated values, legitimisation strategies and expertise, and as a situated and embodied practice (Entwistle 2000a; 2000b). Following McRobbie (1998; 2016a) and Kawamura (2004; 2018), I see the centricity of the Romantic author-function (Foucault 1998 [1969]) as the key legitimisation strategy of the traditional fashion design profession, defining the designer's position in the hierarchy and stratification system of the field. The contextual embodied knowledge of fashion designers is the professional jurisdiction that differentiates them from other fashion and design professionals, non-professionals and non-humans, and links their profession with their concrete work (Abbott 1988). With the authorial and institutional aspects that construct designers' professional legitimation, jurisdiction forms the scaffold of the traditional figure of a fashion designer. This figure is not fixed, universal or exhaustive: since Worth's time, it has become increasingly complex and

fragmented (Volonté 2012, 400). Digital fashion designers intentionally further deconstruct the figure, decentring the professional fashion designer and even the human.

2.2.3 Technological posthumanism and contemporary fashion

> Creating fashion for the non-physical space requires us to push our own neural buttons at the same time as we code the drape and fit of a digital garment. From our perspective, the 3D fashion we create is not just a matter of digital dress-up, but a way to transmit emotion as we iterate humanity in a new realm of existence. (Larosse / The Fabricant 2021)

Digital fashion is posthuman on many levels: processual; authorial and professional (digital companions, networks, data companions); aesthetic (fluidity, liquidity, fictional materials); and conceptual (non-human avatars, bodies, environments, spaces). Posthumanism (nowadays also called a *more-than-human* approach) addresses the entanglements between the tangible and intangible, human and non-human worlds (Vänskä 2018; Smelik 2021). In doing so, it critically undoes the heritage of humanism, the concept of "human" and anthropocentrism, drawing from post-structuralism, postmodernism, deconstruction, and critical feminist and postcolonial theory (Hayles 1999; Herbrechter 2013; Vänskä 2018, 27). The "post" in *posthuman* does not refer to something *after* human but rather criticises the human-centricity and superiority of a certain human concept in relation to the "other" (Vänskä 2018, 17, 27; Smelik 2021, 58; Braidotti 2013). The "other" is non-human – organic things like flora and fauna, bacteria, fungi or energy resources, or inorganic spheres, such as technologies, robotics, AI or synthetic textile fibres. It can also encompass members of the human species who are seen as less human, e.g. children (Vänskä 2017b). The posthuman perspective attempts to *decentre the human* (Vänskä 2018, 17), deconstruct all sorts of binaries (Smelik 2021, 60) and reconstruct a non-hierarchical relationship between humans and non-humans (Hassan 1977, 201–217), showing that there is no such thing as essential or unchanging humanity (Vänskä 2018, 27). Following these premises, I apply the posthuman lens to digital fashion designers, who are characterised by the act of decentring the human, the body, the author and the professional alike.

Posthumanism became particularly known as a concept through Kathrine Hayles's book *How We Became Posthuman* (1999) and is therefore often associated with technology and how the human is technologised, virtualised and merged with machines. Technological posthumanism (or feminist technoscience) is also the perspective of this thesis. Hayles (1999, 3) argues that the human body is treated as a modifiable object, a "cultural artefact, a material-informational entity", and an interface between nature and technology. For Hayles (2012, 3) we live in technogenesis, by which she means that we co-evolve with technology on the cognitive, unconscious, embodied and physical levels, where computers become extensions of human bodies and cognition. In technogenesis, humans think through, with and alongside digital media.

Human agency, thought and embodiment are enmeshed in and extended through digital technologies and networks (Hayles 2012; Lupton 2017, 1601). Hayles (2017, 13–14) also states that nonconscious cognition of biological organisms bears functional and structural similarities to that of technical systems, in terms of "building up layers of interactions from low-level choices, and consequently very simple cognitions, to higher cognitions and interpretations".

Digital technologies that designers use also become extensions of their bodies, co-evolving in a state of technogenesis. Designers learn from the software and vice versa; designers incorporate the workflow and use their bodily experience to "feel" the garments (see Publication III). In algorithmic design technogenesis goes further, as the designers work through, with and alongside digital software and turn their own embodied knowledge into numbers (see Publication IV), becoming a human-computer-designer hybrid.

One of the most influential theorists in the area of technological posthumanism, Donna J. Haraway, proposed the concept of *cyborg*, referring to a cybernetic organism that is a "hybrid of machine and organism, a creature of social reality as well as a creature of fiction. Social reality is lived social relations, our most important political construction, a world-changing fiction" (Haraway 1985, 65). I see fashion, too, as a political and world-changing fiction, especially digital fashion, which builds fictional worlds to provide experiences beyond this moment and place. The idea of a non-hierarchical fashion world might also be a fiction, a point of reference, helping to construct the desired fashion culture. The cyborg "creature" is the artefact but also the designer and the technology that the designer works with. The concept of the cyborg emphasises the heterogeneous and historically situated intertwining of humans and non-humans, "[…] a posthumanist configuration in its hybridity between human flesh and metal or digital material, and in its wavering between mind and matter" (Smelik 2021, 59).

Emergent human ontologies are established through relational encounters with technologies and other entities. The cyborg blurs the boundaries and transgresses the hierarchical relations between binary categories like biology vs. technology, real vs. artificial, fiction vs. reality, nature vs. culture, physical vs. non-physical, idealism vs. materialism, or body vs. mind. As Haraway (1985, 67) writes: "The cyborg is resolutely committed to partiality, irony, intimacy, and perversity. It is oppositional, utopian, and completely without innocence." Furthermore, a "machine is not an *it* to be animated, worshipped and dominated. The machine is us, our processes, an aspect of our embodiment" (Haraway 1985, 99). Another concept that Haraway (2003; 2016) has formulated is "companion species", i.e. "post-cyborg entities": assemblages of humans and non-humans that live together and co-evolve. These assemblages generate new forms of liveliness, relations and socialities (Haraway 1985). The concept of a *companion* is also suitable for discussing technologies that interact with humans and steer their behaviour, such as generative computer algorithms for fashion design (see section 2.3.3).

Drawing on Haraway and Hayles, Deborah Lupton (2017, 1599–1601) talks about "data sense", a product of intimate entanglement and negotiation between digital data and embodied experiences. Data represents our own life and the lives, behaviour, thoughts, opinions, commodities and bodies of others in numerical form. It is the fabric between the human and machine and the fuel on which algorithms operate. Data creates new ways of experiencing the everyday and of conceiving bodies, the self and social relations. Lupton frames the ontologies of personal digital data and digital devices as companion species (Haraway 2003; 2016) that co-habit and co-evolve with people. The devices are configured based on users' interactions, bodies and experiences. Users shape their ways of using the devices, their "modes of being and concepts of selfhood", correspondently with the devices' designs and data assemblages (Lupton, 2017, 1603).

In 2018, fashion scholar and queer theorist Annamari Vänskä (2018) proposed a posthuman theoretical framework to reconstruct our understanding of fashion and of fashion as a theory of the human – a *performative act of hominisation* (Vänskä 2018, 22) – building her argument on Judith Butler's (2004) account on the gendered nature of being "human" as a performative act. Vänskä (2018, 17, 27) argues that posthuman fashion is an "ethical and a political project" that *decentres the human* to do justice to the complexity of humanity and to provide a new, more ethical notion of fashion. Vänskä (2018, 15) wants to bring about a shift from seeing fashion "as a means of constantly reconstructing one's identity through hectically changing trends (commercial self-fashioning) to understanding fashion as a form of critical thinking and as a sustained process of conceptualising, defining and contesting the limits of the human and humanity" (Vänskä 2018, 15).

Fashion designers can practise such critical thinking. Vänskä analyses fashion for non-humans, namely dogs, and how such an act of slow hominisation reconceptualises fashion. Vänskä argues that by dressing our dogs, we hominise them. As fashion itself is a tool for posthumanist critique (Vänskä 2018, 28), digital technology adds new layers and possibilities to queer fashion practices and human form (Evans 2018). In the digital fashion world, the posthuman figure has become a point of differentiation. The manifesto of the Institute of Digital Fashion, one of the leaders of digital fashion discourse, asks us "to re-imagine a space where marginalised voices can be heard and given a platform where they are represented fairly."[12] Digital fashion also goes beyond humans and other earthly creatures. For example, the first-ever virtual modelling agency, The Diigitals, offers an alien model, Galaxia.[13] The Fabricant also creates non-human avatars that possess a human body shape. This pushes designers to think about what makes a body human, as their producer (interview, 19 November 2019) recalls from some of their meetings:

[12] See https://indd.adobe.com/view/3991a46d-a089-4278-a11e-64f1710d7cc2 [accessed 15 February 2022]

[13] See https://www.thediigitals.com/models [accessed 15 February 2022]

> So sometimes, without knowing, you get into conversations like, yeah, we like faceless, and then you say, okay, faceless. But with faceless […] it can be a mouth hole and something like dark eyes. That's also faceless because it's not like a real person. I mean, we quite like that because it's also the future that can be more inclusive. With this whole kind of digital fashion, you can do it.

The posthuman critique in fashion extends to entanglement issues with non-humans, also from the perspective of sustainability (Vänskä 2018, 18). Seeing the planet and everything on it as companions rather than passive resources, and consumers as active embodied subjects "becoming-with" non-human entities – including clothes – furthers our engagement with such entities and our ecological "respons-ability" (Haraway 2016; Valle-Noronha 2019). Although the term posthumanism is ambiguous (Herbrechter 2013, 57), it should not be confused with transhumanism or techno-optimism because posthumanism is more of a critical framework. The idealisation of cyborgs, AI and other cyberculture fantasies has led to a "celebration of disembodiment and immateriality," and such "flight from flesh" requires critical examination (Smelik 2021, 60; 2008, 135). The concept of structural similarity between a computer and the human mind – a mind that can be downloaded to or replicated by a computer – fortifies the Cartesian dualism and hierarchy between mind and body (Hayles 1999).

Fashion scholar Anneke Smelik (2021, 60; 2018) suggests that in the case of fashion, posthumanism should be placed within the theoretical framework of new materialism, which undoes binaries and complexifies hierarchical dualisms, highlighting matter as well as an "embodied and embedded posthuman subject in process" (Braidotti 2019, 11). Human subjects are situated dressed bodies (Entwistle 2000a), embedded in time and space, and entangled with human and non-human in the process of becoming (Smelik 2021, 60; cf. Busch 2009, 38). Process-centricity is another principle of digital fashion that is never finished, in a constant state of becoming because of the network-based flows, community legitimisation and immaterial ontology of the works and working space (see Publication III). In an algorithmic and open-source fashion, processes rather than products are designed (see Publications II and IV).

Illustrating with numerous examples, Smelik (2021) argues that since the era of conceptual fashion (the 1980s–1990s), and especially lately with novel technologies, fashion has embraced a "posthuman turn" that pushes and blurs the boundaries between humans and non-humans (animals, machines, extra-terrestrials and imaginary creatures), organic and artificial, and what "human" actually means. Smelik (2021, 60–61) draws parallels between current posthuman feminism and gender fluidity in fashion. Posthuman fashion appears in different dimensions of posthuman cyborg aesthetics, critique, queerness and sustainability (ibid.; cf. Vänskä 2018; Evans 2018). Smelik's (2021, 58) account of posthuman fashion follows the one of Vänskä's, depicting the posthuman as "a hybrid figure who decentres human subjectivity, celebrating in-between-ness, by making alliances with all kinds of non-humans." Both Smelik (2021) and Evans (2018) present as an example of posthuman fashion athe Dutch designer Iris van Herpen, whose aesthetics and

working methods are both posthuman, as an example of posthuman fashion. Van Herpen seeks inspiration in non-human worlds, creates fractal and complex shapes unattainable to manual human design, works with algorithms and generative design, and uses digital manufacturing methods, including 3D printing. Van Herpen combines digital technologies with high-level manual craftsmanship (Smelik 2021, 60; Smelik 2020). The same applies to digital fashion designers who merge their embodied knowledge with algorithms and/or digital craftsmanship. Furthermore, posthuman aesthetics of fluidity and liquidity, in-between the hyperreal and unreal, are often pursued in digital-only fashion (Publications III and IV).[14]

Wearables and fashion-related AI have inspired posthuman discussion on human bodies, datafication and fashion technology (e.g. Förster 2018). Integrating new technologies into clothes contributes to the continuum of fashion yet transforms both human-machine and human-human relationships (van Dongen 2019, 260–261). Technology designers participate in creating morals: for example, an irritating beeping sound in a car is designed to force the human to put on their seatbelt (Verbeek 2005, 212). Objects might not carry out moral evaluations or have intentions, but they can act, mediate and contribute to moral evaluations of humans, which should be anticipated, especially by the designers (Verbeek 2005, 213–214). This is increasingly relevant with the development of wearable technologies and artificial intelligence, which can influence people without them even noticing (Förster 2018). For example, an e-textile that follows a human's bodily functions informs other devices and shapes the wearer's behaviour. An e-textile is a sort of *digital skin*, which, according to Yvonne Förster (2018, 36), "implies to alternate forms of embodiment and poses the question of the importance of the body." A digital skin can also be a virtual outfit, an avatar, a prosthesis or a video projected onto a body, but, most importantly, it is a posthuman logic that shapes human cognition. Humans have always "folded virtual into the real" in the form of storytelling, image-creation and fashion (Förster 2018, 38). Fashion can become a medium for critical reflection on the development of technologies (ibid. 42). Digital fashion holds the same potential because storytelling is one of its fundamental building blocks.

Human-machine assemblages, where humans and machines shape each other, are also identified and discussed from the posthuman perspective in areas of fashion technology such as generative garment design, which critically comments on conventional fashion design practices (Valle-Noronha 2015). Designer-researcher Julia Valle-Noronha and software developer Luis Castilho created a system called Generator, for which they developed computer software that distorts flat garment patterns within set parameters and generates unexpected forms for use by a designer in draping unique garments (ibid.). The creators of Generator view their project through a phenomenological and posthuman lens, asking whether they are "bringing virtual and vital processes

[14] See e.g. The Fabricant's Iridescence dress https://www.thefabricant.com/iridescence, or the work of Tribute Brand, @tribute_brand https://www.instagram.com/tribute_brand/ [accessed 4 June 2022]

closer together" (ibid., 5). In their experience, both machine and human creators alter each other's work interdependently. Valle-Noronha (2015) argues that also digital processes possess a sort of vibration beyond a simple digital experience, forming interconnected assemblages with humans. As a fashion designer, Valle-Noronha found the process novel and liberating, due to its fluidity and to the possibility of bypassing traditional pattern-cutting knowledge and "transforming error and chance into useful parts in a design process" (ibid., 5). For Valle-Noronha, their project echoes the mid-twentieth-century conceptual art that relied equally on chance and open-endedness as fuel for the creative process (cf. Clark 2012). My case studies have a similar mindset, with a conceptual approach not only to the works but also to how they are made, building unforeseen workflows, restructuring underlying systems and redistributing power among professionals and laypeople, humans and non-humans (see Publications II–IV).

I use Haraway's term "figure" to understand fashion designers' becomings. Figure refers to an outcome of figuring, which stands for or displaces something else (Haraway 1997, 11). Design researcher and co-design theorist Sampsa Hyysalo (2010, 246) sees figuration or figuring as an act of formation, which draws attention to different layers and modes of configuration. Hyysalo (2010, 245) states that "[…] the gradual and continuous shaping of technology that takes place in multiple arenas and modes in the life of a technology […] is literally con-figuration, 'figuring with,' weaving things together into assemblies and capabilities for action," making technology an "evolving mesh of materialised characteristics" (ibid., 249; Hyysalo, Pollock and Williams 2019, 13). Hyysalo (2010, 246) proposes a *configurational model of technology*, meaning that technologies are "orchestrations of multiple layers of configuration," not designed in a linear way or for rigidly scripted usership, but being ever-evolving results of multiple circumstances, human collaboration, local contexts and so on. Configuration has four dimensions: pre-, re-, de- and co-configuring. Hyysalo (2010, 252) argues that aspiration and imagination in technology configuration are not individualistic but "dependent on its partial materialisations."

When applying this thought to fashion design technologies, we can see how software interfaces, visualisation quality, designers' workflows, the bodies involved and the surrounding zeitgeist all interweave in the biography of technologies and designer work. Pre-configured 3D design software was first developed primarily for patternmakers and game designers, and then de-configured and re-configured by amateur designers who started to use it for designing fashion outfits for virtual spaces. Users' adaptation of technologies might differ significantly from the developers' intentions because they have different skillsets and motivations (ibid., 247). Digital 3D design software was then co-configured with fashion designers to make it as easy and useful as possible for this new user group. The visualisation quality equivalent to and learned from visual effect tools inspired fashion designers to try novel software, having an interface that was now optimised for fashion designers.

The digital tools and media that designers interact with have agency on the way they think, also influencing the products designed or made with such tools (Boczkowski 1999; Ihde 2001; Latour 2005; Atkinson 2017, 151). The software developers who have pre-configured the affordances of the tools (see Publication III) have agency on the work of designers, who, as human beings, tend to choose the most accessible paths. All the software users passively co-configure the software by providing usage data. They apply their embodied knowledge, acquired from garment construction and wearing garments, as well as from using other digital software, for designing using software they already master (Illustrator, Photoshop). The zeitgeist of fluidity and "re-framing the broken [fashion] system"[15] drives designers to adopt and experiment with new tools, code and product-service systems, adding another layer to the development of various technologies, from 3D software to algorithmic models.

2.3 Previous research

The related literature preceding this doctoral research addresses alternative ways to approach fashion design authorship and professionalism, using recent digital tools in phygital spaces and designing with algorithmic digital companions.

2.3.1 Alternative fashion design authorships and professionalisms

In my MA thesis (Mustonen 2013) for Aalto University, I studied fashion openness as a new paradigm that changes the relationship between designer and consumer and tackles sustainability problems. The research was inspired by the work of Otto von Busch (2008), who suggested that fashion practice should be opened to anyone who wants to participate in it. Combining the idea of design activism (Fuad-Luke 2009) and hacking couture (Gonzalez 2006; Scaturro and Granata 2006), von Busch (2008) coined the term "fashion hacktivism". Fashion hacking borrows from software programming and stands for a networked, constructive, collaborative and participatory practice that contrasts the hierarchical fashion industry and empowers amateurs to hack designs and products according to their preferences and needs. Similar approaches that presuppose a layperson's active role are popular in design research. For example, in co-design practices, the professional designer "make[s] the tools for non-designers to use to express themselves creatively" (Sanders and Stappers 2008, 14). The designer becomes a facilitator who leads,

[15] The manifesto of the Institute of Digital Fashion (IoDF), founded by Cattytay and Leanne-Elliott Young. Cattytay is an early digital fashion designer and an influencer in the field, who also in 2018 founded the DIGI-GXL: a community for "womxn, trans, intersex and non-binary digital designers in what remains a male-dominated industry." Their goal was to offer support and advice to the queer community of creators. Inclusivity and democratisation are at the core of the IoDF manifesto. See https://indd.adobe.com/view/3991a46d-a089-4278-a11e-64f1710d7cc2 [accessed 15 February 2022]

guides and synthesises. The co-design approach is considered especially beneficial when dealing with wicked and complex problems that are hard to define (von Hippel 2005; Hyysalo 2010; Manzini 2015).

Digitalisation has pushed design practices to more decentralised and de-professionalised socio-organisational structures, raising discussions on professionalism and authorship, and on the disappearing boundaries between the professional designer and amateur (Atkinson 2010; Wu 2010; Peterson et al. 2011; Smith et al. 2012; Mustonen 2013; Hirscher 2013; Beegan and Atkinson 2008; Manzini 2015; Hermans 2015; Peterson 2016). "Openness" has become a buzzword that indicates free information, liberated from enslaving hierarchies, and solving contemporary problems with commons-based peer-production (see Publication II, Särmäkari and Vänskä 2020, 2411–2412; Pomerantz and Peek 2016; de Mul 2011, 37; Leadbeater 2009, 39; Thackara 2011, 44; Benckler 2006; von Busch 2008). Design theorist Jamer Hunt envisioned in "A Manifesto for Postindustrial Design" (2005) that design would leave behind the heavy machinery and overproduction of goods and move to the world of code. Hunt argued that distributed intelligence, computer-aided design and manufacture, and ecological realities drive towards a post-industrial design that is free, decentralised, distributed, open-source, dynamic, adaptable, accessible and less wasteful. Hunt values skillsets beyond traditional professionalism, and authorships beyond single designers. One might find a connection between posthumanism and post-industrial design (Hunt 2005, 120):

> Sacred oppositions, such as human and machine, mind and computer, matter and information, real and virtual, and natural and artificial no longer seem so absolute in our dream world of transgenic species, prosthetic intelligence, augmented reality and DNA computers.

Post-industrial design is also the key interest of this doctoral study, where I call this type of design approach an open-source philosophy. My MA thesis (Mustonen 2013) left me wondering whether and exactly how open-source fashion philosophies are manifested in real-life settings. Therefore, I wanted to explore this topic further in my doctoral thesis. I also felt that open-source fashion required critical examination, which had been lacking in my prior thesis and in other optimistic academic and professional texts (e.g. Niessen 2010; Bollier and Racine 2005; van Strien and de Pont 2016).

All of the case studies in this research apply an open-source philosophy, although their methods vary. The idea of open-source fashion is linked to the philosophy behind open-source software development and open design, which refers to design "[…] whose makers allow its free distribution and documentation and permit modifications and derivations of it" (van Abel, Evers, Klaassen and Troxler 2011, 11). Bollier and Racine's (2005) work was mentioned as a fashion example in the principal book on *Open Design* (van Abel et al. 2011). They proposed that the contemporary notion of creativity is manifested in the open and participatory digital culture. Therefore, fashion too should embrace the "ready-to-share" attitude (Bollier and Racine 2005). In fact, fashion culture as a field where appropriation, derivation, imitation, plasticity and remixing are

typical means of creation is implicitly similar to digital culture (ibid., 5). Creativity in fashion design could flourish in an open-source environment and contrast with other creative fields that rely on ownership and copyright protection (ibid.).

Designers Martijn van Strien and Vera de Pont proposed similar thoughts in their *Open-Source Fashion Manifesto* (2016), according to which technologically enabled open-source fashion could contribute to sustainable systemic change and save the value of fashion as culture. This idea also drives my case studies' digital fashion designers: they want to cure the fashion culture rather than destroy it because they appreciate it and feel that their methods are feasible. The *Openwear* e-book, online community and research project (Niessen 2010) first offered a platform of and for open-source fashion, and since then, many scholars have seen the potential of open-source creation for solving ecological and social problems (e.g. Niinimäki and Hassi 2011; Hirscher 2013; Hirscher, Niinimäki and Armstrong 2017; Hur 2014; McQuillan et al. 2018). The expertise of fashion designers can be disputed through digital facilitation of open-source design (McQuillan et al. 2018).

Publication II (Särmäkari and Vänskä 2020) investigates the topic of open-source fashion design through three empirical case studies. As we argue in Publication II, an open-source philosophy in fashion entails a broader notion of an *open-source attitude towards fashion practices* instead of being a particular type of open design (Särmäkari and Vänskä 2020; cf. Vainio and Vaden 2012; Bakırlıoğlu and Kohtala 2019). The notion of "open-source fashion" is close to what Hermans (2015, 75) calls transparency – a characteristic of a designer role in which the designer is open about the design and manufacturing processes and gives skilled and motivated amateurs the possibility to modify or build on the designs. For example, Atacac's designers talk about the "transparency project", their Sharewear platform that shares free patterns for users to cut or modify. Atacac has also been providing free 3D outfits in a virtual world, Sansar. The Fabricant has recently launched The Fabricant Studio, a community-funded open ecosystem where "anyone, anywhere can become a digital fashion creator and participate in the digital fashion economy."[16] The Fabricant started their transparency project by sharing 3D files for free on their website, openly consulting a large Facebook community (now a Discord community) and streaming their processes on the game streaming service Twitch.

Open-source thinking might, however, have unwanted consequences. According to Heidi Härkönen (2021), the copying culture of fast fashion, enabled by the inability of IP law to protect fashion design works, is intrinsically linked to the environmental, social and cultural unsustainability of the fashion industry. This problem worsens if artificial intelligence starts designing: the non-human designer falls into the public domain that cannot be protected, while potentially being extremely fast and excessively productive (Härkönen 2020). Furthermore, von Busch (2016; 2019) himself suspected that open design might amplify a neoliberal attitude, inequality and hierarchies instead of flattening them, giving power to those who already have it: "The very narrative

[16] See https://www.thefabricant.com/thestudio [accessed 20 February 2022]

of the maker-community has a tendency to see the individual as an entrepreneur or self-employed factory-worker, where every participant is an 'army of one,' their own soldier of fortune" (von Busch 2016, 138, English translation by von Busch). The ethos of openness and transparency might even have a panopticon self-regulation effect (see Vallor 2016). In other words: openness works best in cases where laypeople can evaluate whether they get something valuable enough from participation and choose whether they want it in the first place.

The cases of this research do not practice open design but rather apply an open-source philosophy by sharing models and knowledge, allowing customers to play with and even monetise on the works derived from their models. Publication II (Särmäkari and Vänskä 2020) presents a case study on the Finnish company Minuju, which wanted to invite children to play with design and, through this, to increase emotional attachment to their clothing and thereby maximise longevity. They developed a digital platform that would be easy for children to use with their parents (Kyber 2017). The designers' task was to create modular products by defining the elements upon which the consumer has co-design agency. Minuju's product-service system represents a larger fashion design an retail phenomenon called mass-customisation. This refers to the production of cost-effective apparel, tailored according to individual wishes within a given product line (Pine 1993; Lee et al. 2002; Satam et al. 2011; Hur 2014; Nayak et al. 2015). Such elements are usually multiple-choice options related to fitting, colours, lengths, attachable details, applications, prints and/or materials, the modification and implementation of which are enabled by digital interfaces and flexible manufacturing (e.g. Lee et al. 2002; Aichner and Colletti 2013; Wang, Shen and Liu 2017; Peterson 2016). The post-industrial landscape has generated digital manufacturing and co-creative product-service systems of this kind (Wu 2010; Peterson et al. 2011; Kyber 2017; Nachtigall, Mironcika, Tomico and Feijs 2020; see Publication II). At Minuju, production happened in a traditional studio. In contrast, Matti Liimatainen's Lego-like Self-Assembly (Publications II and IV) has built a laser cutter and algorithms to enable the modular design of garment blocks that can be assembled, disassembled and reassembled by the users themselves.

An open-source philosophy and the distributed authorship of designers are not the only ways to look at alternative professionalism of fashion designers. Many scholars have been developing novel practices through their own artistic work, carrying out practice-based research (e.g. McQuillan et al. 2018, 2020; Finn 2014; Valle-Noronha 2019). Some scholars – like myself – have been studying others' practices, carrying out research on the expanded roles of fashion designers and proposing new designer roles (e.g. Aakko 2016; 2019; Chun et al. 2017; Chun 2018; Huopalainen 2016; Thornquist 2011; Kauppi 2021). Just as the overall need for redefinition of what we understand as fashion (Vänskä 2018), the environmental and social problems of the fashion industry drive design researchers to seek redefinition and "re(-dis)covery" (Chun 2018) of fashion designers. Some fashion designers have returned to the abandoned roots in craftsmanship in the form of "artisanal fashion" (Aakko 2016; 2019). Some apply their "fashion design thinking" to projects with a broader social

impact and place-making capabilities (Chun 2018) in the same way as industrial designers harnessed "design thinking" methods, including design management and consultancy, to solve problems far off physical commodities (Sparke 1983; Valtonen 2007; Julier 2008). Both Chun (2018) and Huopalainen (2016), having studied designer practices in small Finnish fashion studios, problematised the figure of a heroic star designer, as did McRobbie (1998; 2002) and Kawamura (2004; 2018), proposing a more managerial role and community-centred designer figure. Huopalainen (2016, 102) points to the designer as part of "collective, uncertain, emerging, 'messy' and trial-and-error processes instead of the designer's personality or unique qualities."

Digital fashion practices echo community-centric views but also artisanal fashion (Aakko 2016; 2019), in terms of the craftsman's attitude of doing their job well (Sennett 2009) and the "artist-craftsman's" attitude, combining technical skills and high-level aesthetics (Becker 1982). According to Aakko (2016; 2019), the artisanal mode of production is embedded and embodied in slow fashion values[17] (Clark 2019; Fletcher 2008). Artisanal designers work seamlessly with their team, manage the company, sell the products, create the concepts, monitor the aesthetics, learn continuously through doing, and possess solid technical proficiency (Aakko 2019, 542–544). Such a multifaceted role tends to be the case in small fashion companies (e.g. McRobbie 1998; 2002; 2016a; Huopalainen 2016), including digital fashion businesses (see Publications II-IV; also Särmäkari 2021b). An emphasis on materiality, the tactile processes of making, draping, patternmaking and sewing, and the imperfection of handprint (Aakko 2019, 540–541, 545) is their differentiation strategy and novel professional jurisdiction, in the same way as digital fashion designers highlight their digital craftsmanship (see Publications III and IV; also Särmäkari 2021b). Artisanal designers typically spend time on their often pre-industrial making processes – the "whole garment method" – where the same person constructs the entire garment, in contrast with the fragmented "section work" of industrial garment manufacture (Aakko 2019; 541, Belfer 1954). Digital fashion designers approach the "whole garment method" in their way, either by running a micro-factory in their studio, creating modular garments, developing a manufacturing robot or producing digital-only garments by draping on an avatar (see Publications II-IV; also, Särmäkari 2021b). The digital tools define which role the designers have when constructing the garment.

2.3.2 Digital tools

This research focuses on technologies *for designing* and technological environments directly related to the transformations of the authorial role and professional jurisdiction of fashion designers. Technologies for designing are computer-aided design software (CAD), including Adobe Illustrator and Photoshop, as well as designer-specific 3D software, which now predominates.

[17] Slow fashion opposes the accelerating pace, seasonal thinking and unsustainability of fast fashion, striving towards economic, social and ecological balance and emphasising care, attention and appreciation for clothes, their makers and wearers (ibid.). In-house or local production enable control over all the stages and the quality of the garments.

The digitalisation of fashion design processes started in the 1990s with 2D CAD tools that have become part of the everyday work of fashion designers, converging analogue and digital image-making (Braddock Clarke and Harris 2012, 61). Mastering CAD is typically a requirement in the current job market (Sinclair 2014, 673; Bye and Sohn 2010, 200; McKelvey and Munslow 2012, 132; Sun, Li and Wang 2014, 1042). The development of AI, computer power, data availability and computer-generated imagery (CGI) tools has enabled user-friendly and advanced 3D garment design software, such as CLO3D, Browzwear VStitcher and Optitex (Mattila 2016).

Practices that produce 3D virtual clothing as prototypes or sample representations for tentative physical garments and/or virtual, digital-only garment simulations are in the professional and media discourse (as in this thesis) referred to as *digital fashion*. Digital 3D fashion design is a rapidly growing and arguably the most significant phenomenon disrupting the fashion industry as we know it (BoF and McKinsey 2020a). It tackles the processes of design, the whole supply chain and the dynamics between different professionals and laypeople (Särmäkari 2021b; BoF and McKinsey 2021; see Publications III and IV, Särmäkari 2021a; Särmäkari and Vänskä 2022). COVID-19 lockdowns and travel restrictions have contributed to faster development, prevalence and social acceptance of digital(-only) fashion, forcing companies to accelerate the digitisation of their practices (Särmäkari 2021b; BoF and McKinsey 2020b; Noris et al. 2021; Nobile et al. 2021).

Literature on digital 3D fashion is dominated by research on design tools and processes. Digital 3D fashion has been addressed in research on virtual fashion in relation to localisation of garment production (Mattila 2016); the tactile experience of digital fashion (Petreca 2017); virtual fitting (Batista 2013; Baytar and Ashdown 2015; Lee et al. 2021); use of AI in the evaluation of fitting and visual experience of virtual 3D-garments (Hong, Zeng, Bruniaux and Chen 2018; Liu et al. 2018); virtual reality stores (Park, Im and Kim 2018); zero-waste fashion design and sustainability aspects of digitalisation (McQuillan 2020; Black 2019); 3D design for disabilities (Kaiser et al. 2014); costume and game costume design (Makryonitis 2018; Stein 2009); digital replication and conservation of historical garments (Moskvin, Kuznichev and Moskvina 2019); and virtual garment design prototyping (Volino, Cordier and Magnenat-Thalmann 2005; Arribas and Alfaro 2018; Spahiu, Shehi and Piperi 2014; 2015; Spahiu et al. 2021). Digital fashion has been touched upon in many textbooks, although under different terminology (e.g. Quinn 2002; 2012; Braddock Clarke and Harris 2012; Luce 2019; Toeters 2019; Makryniotis 2015; Watstein and Czarnecki 2010). Nevertheless, in its contemporary meaning, it has been most widely covered by the media, such as Maghan McDowell in *Vogue Business*. Other active "digital fashion" writers, promoters and speakers are Karinna Nobbs (freelance fashion tech expert and HOT:SECOND founder), Amanda Cosco (Electric Runway), and Matthew Drinkwater (Head of Innovation Agency at London College of Fashion).

Digital fashion has existed as a processual tool since virtual cloth modelling was developed in the 1980s for the film and gaming industry, which was the

economic driver for computer-generated 3D modelling (Sinclair 2014, 673). 3D modelling entered patternmaking in the 2000s when 2D patternmaking software was combined with 3D visualisation (Baytar and Sanders 2020, 110). Patternmakers have progressed from drawing physical patterns to digital pattern design and 3D prototyping earlier than fashion designers (Grice 2019, xvi; Makryniotis 2015). The roots of fashion-design-specific 3D software lie in the tools created for game costume designers and patternmaking. Many fashion 3D software programs were initially patternmaking tools (Mattila 2016). 3D software such as Browzwear VStitcher, Lectra Modaris 3D Fit and Optitex 3D Runway import pattern files from professional 2D pattern design tools and were developed to save time and sampling expenses, because 3D models allow the designer to see the prototype worn on a 3D avatar body (Volino, Cordier and Magnenat-Thalmann 2005, 597; Sun et al. 2014; Mattila 2016, 1–2; Jhanji 2018; Spahiu, Shehi and Piperi 2014; Särmäkari 2021b).

Apparel 3D technologies are also rooted in visual effect software and game costume design software, including Marvellous Designer, which as created earlier by the same Korean company as that makes CLO3D. All of the case studies of this thesis use CLO3D because they found its user experience and visualisation quality optimal, the price feasible and the system interoperable with other software they use. Browzwear is optimised for the industry as it communicates seamlessly with the pattern libraries. For example, Adidas, for example, has developed its own 3D software, named "Lotta", through a collaboration between with Browzwear and Adidas designer Lotta Jurica.[18] CLO3D and Browzwear VStitcher are both active in cultivating their user communities.

3D sampling for design and product selection purposes has been acknowledged as a prospective communication method in the industry by researchers including Hayes et al. (2012, 172), who argued that digital 3D technologies are developing towards a stage where virtual samples are sufficiently realistic to help decision-making processes, fitting visualisation and assessment. It was – and still is – most common that buyers handle physical samples and see them in motion on a human model, but rapid advances in 3D technology are changing this: Tommy Hilfiger was the first big fashion company to be vocal about transforming their sampling and showroom practices entirely to digital 3D by the year 2022 (McDowell 2019). Sports companies, including Adidas, Puma and the Finnish brand Halti, have integrated 3D design into their processes, as lately have luxury fashion companies like as Diane von Furstenberg and Gucci (McDowell 2020; Fablehti 2020; Krantz 2022). 3D garment simulation is more than just an image or a pattern. The 3D model comprises the same structural data as a physical garment and has to be stitched together in the software. The material data is equally exhaustive, containing the numerical representation of material qualities such as weight, stretch, bending, density and buckling (Särmäkari 2021b). The software provides the material

[18] Lotta Jurica's talk at FIT, NYC, 30 May 2018. "Adidas at Browzwear 'Inspiring the Digital Revolution'" event, see https://www.youtube.com/watch?v=oYaJgZQIlQo [accessed February 2022]

data libraries, but the data can also be measured from a fabric swatch using a unique physical fabric kit provided by CLO3D and developed for companies to virtualise their material libraries. The quantified fabric determines how the garment drapes and falls. Enhanced with correct lighting and animated motion, the virtual material simulates the real experience. Thus, 3D visualisations are garments' digital twins (cf. Pires et al. 2019). The design work happens as a dialogue between the 2D and the 3D sides of the software and depends on the designers' preferences regarding starting from the pattern or draping. For example, Atacac's designer Rickard focuses on the pattern side because this is how he also works with physical design. The Fabricant's Amber Jae Slooten starts with draping because she enjoyed this kind of intuitive workflow in the physical realm.

3D files can be uploaded to pattern grading software and from there printed as 2D patterns. In addition to the traditional cutting and sewing, 3D files can be brought to the physical realm through rapid manufacturing technologies, such as 3D printing, flat-knitting[19] and laser-cutting. Resource-efficient bespoke techniques, familiar from Issey Miyake's A-POC concept, are advantageous for small-scale designers and consumers who wish to be engaged in the design process (Braddock Clarke and Harris 2012, 53, 94, 211). Matti Liimatainen/S-A has built an open-source laser cutter where his computer can send the files directly for immediate cutting in the studio. The laser cutter enables fast production of the complex seam structures that Liimatainen has developed with his algorithms. Digital manufacturing is also how Iris van Herpen was able to bring fractal computer-generated 3D structures to life (Smelik 2017; 2020).

Virtuality and 3D modelling aroused the interest of experimental and conceptual designers considerably earlier than the fashion industry, namely around the late 1980s. MIRALab, for example, started researching the possibilities of the digitally dressed avatar in 1989, and Thierry Mugler experimented with a virtual fashion show in 1998 (Braddock Clarke and Harris 2012, 219). Jane Harris (2005; 2013) was one of the first designer-researchers to explore 3D computer-generated modelling, animation and motion capture technology to create real-time representations of 3D virtual garments. Harris argues that understanding the material process is valuable in working with digital imaging media and explores how tacit knowledge can be taken into the virtual: texture, touch, handling, wrinkling, folding, movement, and visualisation of a worn garment (Braddock Clarke and Harris 2012, 127).

The contemporary fashion designers whom I have studied emphasise the same underlying knowledge and, similarly to Harris, translate their tacit knowledge into digital 3D design using tools closer to the fleshy experience than ever before. Real-time animation, simulation of dynamics with an optimised 3D mesh structure and depicting the materiality in digital form enhance the hyperreal experience of digital 3D garments (Super Bureau 2019). Animation enriches the visual experience and provokes tactile sensations of thickness, smoothness, hairiness, creasing, softness, rigidity, elasticity, drape, creasing,

[19] E.g., Shima Seiki Wholegarment, which is used e.g. by Unmade and Ministry of Supply to produce customised garments on demand.

prickliness, and so on. Harris (Braddock Clarke and Harris 2012, 126) was also interested in the kinetic relationship between the virtual fabric and the body, researching everything from bringing historical textiles to "life" to envisioning future fashion for museums, film and gaming.

The reason for digital 3D design and virtual reality applications having been used considerably earlier in architecture, industrial design[20], the military, marketing and entertainment than in fashion is rather practical: the 3D software that was available was optimised for *hard surfaces*, whereas clothes are soft and draped. In the early stages of digital 3D apparel, the creative possibilities were restricted because the fabric simulation shared the same surface as the avatar body and could not flow and drape separately from the body. After years of development, fashion-specific 3D software has overcome the challenge of draping on a virtual body (Makryonitis 2018, 101–102; Arribas and Alfaro 2018). Computational power and AI methods have enabled such software with more sophisticated visual representation, effective real-time interactivity between the design process and simulation of 3D outfits, and amplified focus on designer-oriented workflows (Stylios, Wan and Powell 1996; Volino et al. 2005; Spahiu, Shehi and Piperi 2014; 2015; Mattila 2016; Black 2019; Greder, Shin and Pei 2020). Advanced user-friendly software has convinced fashion designers to test 3D tools in their creative processes (see Publication III; also, Särmäkari 2021b). Digital 3D design brings patternmaking and fashion design, as well as fashion imagery production and virtual worlds, nearer to each other.

Computer technology in tandem with tacit professional knowledge and manual processes arguably facilitates fashion design creativity (Harris 2005; Bye and Sohn 2010; Arribas and Alfaro 2018). Arribas and Alfaro's (2018) empirical study on a virtual 3D fashion design process suggests that 3D modelling magnifies designers' creative freedom, assists in tracking the various phases of design, permits "3D virtual pre-prototyping", improves communication between the designer and the manufacturer, and enriches the retail experience of the consumer. However, the study also found challenges in adopting 3D software: often, fashion designers lack sufficient software skills and their employers do not encourage costly training and disruptive digital transformations.

Recently, the prospect of lead-time, prototype error and sample number reduction have induced fashion companies to test digital 3D garment simulation in the phases before the physical production of collections (Spahiu et al. 2021). Some sustainability aspects are identified in the use of 3D software: when hyperreal imagery minimises prototyping, sampling and photoshoots, the orders can be placed on demand, shifting the traditional "Design/Make/Sell" model to a less wasteful "Design/Sell/Make" (Black 2019) – or design-present-sell-produce, as Atacac frames it (see Publication II). Environmental and social sustainability goals and demands have driven digital fashion forward. However, there is little research on the actual environmental impact of digital fashion.

[20] 3D software makes it possible to display cars before manufacturing them, for example.

Digital-only fashion retailer DressX,[21] for example, calculated in 2021 that digital clothes have considerably smaller carbon emissions and zero water consumption. However, they have not calculated the impact of non-fungible tokens, criticised for their heavy energy use, and no one knows whether digital fashion practices will cut manufacturing jobs from already oppressed workers (e.g. Stephens 2022).[22] In design, Nigel Cross (2001) found that while CAD might lead to better communication between members of a design team and speed up the process, it also has negative effects, such as inducing stress and reducing staff. Nevertheless, adaptation is inevitable, and fashion designers' professional identity and jurisdiction are under scrutiny.

Sun and Zhao's (2018) empirical research showed that the technologically fuelled paradigm shift of the fashion industry is bringing designers, makers and users closer together, expanding and making designers' roles more complex, turning makers into educators of designers (Sun and Zhao 2018, 362). In evolving technological environments, designers are expected not only to design but also to become technical experts, master 3D-modelling software, communicate and collaborate seamlessly with engineers, and even participate in engineering processes to develop technologies (Sun and Zhao 2018, 368–369). As other designerly fields have shown, digital design tools have made collaboration more accessible and affected the organisational structures of companies that have globally grown in size (Picon 2019). In architecture, the increasingly popular Building Information Modelling (BIM) process, addressed in Publication IV,[23] allows large groups of professionals to work together, using the same tool. In such an interactive environment, the question of power and control becomes central: who is allowed to decide on what, and who is the author (ibid. 34)? Digital 3D software brings fashion designers and patternmakers around the same table or even within the same person, and increases the interoperability between software and different professionals. As Atacac's designer anticipated:

> I think that this would be very good for the product because this will mean that pattern-cutters and designers have to work more closely together in another way. And I think that's only good. Normally they are in different departments even, or different teams, and they use different software. That's not the whole explanation, of course, but it's part of the explanation that they don't understand each other's software. (Rickard Lindqvist, 8 March 2019).

Technology tends to set frames for and drive the creativity of designers' work (Lee 2005; Bolton 2016; Genova and Moriwaki 2016; Bertola and Teunissen

[21] https://dressx.com/pages/sustainability-raw-data-references [accessed 24 January 2022]
[22] Doug Stephens provocatively, critically and pessimistically reflects on fashion in the metaverse in his "Business of Fashion" article (13 January 2022). However, job cuts can take place for many reasons: automation, localization, etc. Digital fashion does not claim to replace physical fashion – only the fast aspects of it. Therefore, in the best-case scenario, companies could have more resources as a result of digital fashion to invest in producing high-quality physical garments. Furthermore, digital fashion can offer jobs in areas other than design.
[23] Case Matti Liimatainen/Self-Assembly builds on this model while creating an equivalent model for fashion design: the Garment Information Model (GIM).

2018). In relation to professional fashion practice, "new technologies" usually refer to developments in textile innovations, digital fabrication possibilities and communication tools (e.g. Quinn 2002; Seymour 2009; Toeters 2019; Crewe 2017). For example, Hussein Chalayan, who is known for conceptual experimentation with fashion and technology, has produced collections with integrated technology, but also films and interactive 3D imagery in collaboration with technical specialists (Braddock Clarke and Harris 2012, 114). The fashion system is growing in various technologies and involving diverse players, including software developers, digital hardware providers, consultants, design professionals and intermediary sourcing companies (Sun and Zhao 2018, 363). Technologies nudge companies towards varying synergies among design and manufacturing and generate demand for novel skillsets of designers who are expected to be familiar with production tools (Tortora 2015; Genova and Moriwaki 2016; Bolton 2016; Sun and Zhao 2018; McQuillan 2020; Sinclair 2014; Hayes, McLoughlin and Fairclough 2012). In addition to communication technologies, design and production tools can bring professionals and non-professionals together on digital platforms and through rapid digital manufacturing (Sun and Zhao 2017; Peterson et al. 2008; 2011; Peterson 2016).

Technologies that aim to solve the problems of sustainability and economic efficiency in fashion production, manufacturing, logistics, retail and the whole lifecycle of garments undoubtedly impact the work of designers (e.g. Scaturro 2008; Black 2019; Bertola and Teunissen 2018; Karell 2021). However, rather than as design tools, they could be seen in the manner of any other elements that set the framework for design. Digital technologies create *affordances* through their architecture and possibilities for action that define how and for what they are used by fashion professionals (Torregrosa Puig et al. 2021, 406–407; Norman 1999; Davis and Chouinard 2017). Affordances are also crucial in digital fashion design and its rise in popularity (see Publication III). The digital tools and media that designers interact with arguably have agency on the way they think, also influencing the products designed or made with such tools (Atkinson 2017, 151; Ihde 2001; Latour 2005). For example, digital 3D software has inspired designers to use materials that look like liquids, as well as other materials that would not work in the physical world.

The case studies also pointed out that avatar design is part of digital fashion designers' work (cf. Spahiu, Shehi and Piperi 2015). Questions of representation are central to digital-only fashion because of avatar design and the importance of storytelling. The embodied and social dimensions of real-world sartorial behaviour are equally part of virtual multiplayer worlds and sports games (Makryonitis 2018, 108–9). Therefore, digital dress can become a vehicle for identities and commerce, linking the electronic entertainment and fashion worlds and bridging the gap between game character and fashion design (ibid., 103). Even non-realistic digital apparel is treated as commodities rather than media surfaces, and artificial scarcity fuels the desirability of such commodities in synthetic worlds (Lehdonvirta, Wilska and Johnson 2009). As Lehdonvirta et al. (2009, 1075) observed in their investigation of the Habbo Hotel online game: "the lack of trendy sneakers at school could be compensated with virtual

dragons and record players." The authors anticipated that this phenomenon might have positive ecological implications. In the digital fashion paradigm, fashion companies can sell their designs in physical and digital forms, and the fashion system exists in two parallel worlds: the physical and the virtual. The current fashion world's fascination with digital virtuality is not a surprise because fashion was "always already virtual" (Vänskä 2021), having and being shaped by the intangible, intellectual, abstract, performative, communicative and visual(-only) dimension that was amplified by photography and the Internet (Vänskä 2021; 2017; Van de Peer 2014).

2.3.3 Digital companions

I propose *algorithmic fashion design* as the third fashion 4.0 phenomenon that contests fashion designers' authorship and professionalism (see Publication IV), where technologies become companions (Haraway 2003; 2016). AI-aided or AI-generated fashion design has intrigued the fashion world, especially around 2016–2019. Companies such as Stitch Fix, Zalando and Amazon were vocal about how they would replace fashion designers with AI (Rietze 2016; Sibley et al. 2016; Knight 2017). Conceptual, creative and ethical reasons have inspired some smaller players to experiment with algorithms (e.g. Valle-Noronha 2015; Pownall 2019). A myriad of applications based on data mining, machine learning, neural networks, genetic algorithms, natural language processing, computer vision, predictive analytics, fuzzy logic and hybrids of all these have been studied by researchers in academia and industry for more than two decades, but especially in the last five years (Luce 2018; Thomassey and Zeng 2018; Yildirim, Seward and Bergman 2018; Guo, Wong, Leung and Li 2011; Inui 1996). The reason for such interest is the hypothesis according to which the fashion industry could benefit from the optimisation and creativity possibilities afforded by AI: personalisation, trend prediction, efficient distribution, product evaluation, local market analysis, fast design process, realistic visualisation and generation of complex structures (e.g. Luce 2019; Thomassey and Zeng 2018; Cui, Liu, Gao and Su 2018; Sbai, Elhoseiny, Bordes, LeCun and Couprie 2018; Kim and Cho 2000; Kato et al. 2019; Mok et al. 2013; see also BoF and McKinsey 2017). Computers have not yet embraced the whole spectrum of fashion designers' professional jurisdiction, which is grounded in tacit embodied knowledge and social acceptance obtained through considerable human effort, but they are helpful in particular tasks as companions in design.

AI automates tasks and processes and can be utilised across the fashion industry in design, production, supply chain management, retail and communication (Guo et al. 2011; Sun and Zhao 2018; Luce 2019). Through the collection of data, AI and machine learning may provide trend prediction with "greater precision, accuracy, and speed," robotics may automate and optimise tasks, and algorithms may even generate virtual designs (Sun and Zhao 2018, 364). User-generated data from social media and other fashion platforms can be crawled, compiled into large datasets and used for various purposes, such as scoring "fashionability" factors in users' outfit-of-the-day photographs (Simo-Serra et al. 2015). Indeed, data mining poses ethical problems because the data,

the processing method and the culture underlying the data and algorithms are biased; therefore, data-driven design practices require dynamic managerial human capabilities (Akter et al. 2021).

Thus, algorithms can *assist* in many ways and their functions can be analytical, guiding, automating or *generative*. The output of generative algorithms is an image, video or other artefacts, "a sort of recombinant variation of the training data" (Luce 2019, 129). I use the concept of *algorithmic fashion* to refer to these various types of utilisation of or collaboration with generative computer algorithms and AI in garment design practices. Although there is no consensus on the meaning of AI (or intelligence overall), it is generally understood as numerical and computational methods solving problems in human-like ways or, more precisely, a field of computer science that "[...] seeks to understand how we think and to re-create this intelligence in machines" (ibid., 4).

As the literature review of Publication IV (Särmäkari and Vänskä 2022) outlines, two different algorithmic fashion design approaches appear the most common: generative adversarial nets (GANs) and genetic algorithms. In discussions on "AI fashion designers". GANs are usually proposed as an appropriate technique because they tackle the assumed core of fashion design expertise: trends, style, creativity and image production (e.g. Luce 2019, 125–132). As an unsupervised learning method, GAN consists of two neural networks that refine each other's skills: one generates the content and the other discerns whether the result comes from the real dataset or was machine-generated (Goodfellow et al. 2014). GANs are the best choice for trend and consumer demand analysis, synthetisation of brand and personalisation, and generating images that focus on particular attributes (e.g. Kato et al. 2019; Kang et al. 2017; Hyun and Lee 2018; Yildirim et al. 2018; Singh, Bajpai and Prasath 2020; Rostamzadeh et al. 2018; Liu et al. 2018). The output is whatever the generative algorithm creates based on the input data and machine learning system, which can be supervised or unsupervised by humans, and based on structured or unstructured data (Luce 2018, 100).

GAN model versions have been developed to conduct "text-to-image translation" to generate images from texts and "image-to-image translation" to generate fashion images from other images (Rostamzadeh et al. 2018; Liu et al. 2018; Yildirim et al. 2018; Cui et al. 2018). GANs can also transfer styles and switch 2D garment images onto images of people (Sbai et al. 2018; Jetchev and Bergmann 2017). For example, Amazon's "AI fashion designer" relies on GANs, using data to predict future demand by generating image suggestions (Luce 2019, 14, 130). Conditional attribute-based variations of GANs were found useful in providing designers with new computer-generated variations of specific qualities of garments (e.g. Yuan and Moghaddam 2020; Yildirim et al. 2018). For example, Zalando's researchers used more than 120,000 inventory images of dresses to train conditional GANs to generate new realistic garment images with set aesthetic parameters related to colour, texture and shape (Yildirim et al. 2018). After images are computer-generated, human input is

needed to design the garment and the pattern (Sbai et al. 2018; Kato et al. 2018; Kato et al. 2019).

In Publication VI, the case study on The Fabricant presents how the designer used GANs to generate new outfit images in 2018. A large image dataset from Paris Fashion Week was fed to the neural networks as input, and vague images with shapes, colours, textures, and silhouettes came out as the output. The designer, Amber Jae Slooten, then chose a few AI-generated sketches and designed 3D outfits and environments together with The Fabricant's network of 3D artists and environment designers. Here, the algorithmic fashion approach could be called *AI-aided digital sketching*, where AI does not really design but provides inspirational visual material.

While GANs are the most popular generative models in AI-generated arts and algorithmic fashion, genetic algorithms are the oldest. Genetic algorithms are more suitable for product development purposes, such as pattern optimisation, generation of complex 3D shapes or creation of random or unimaginable shapes. Genetic algorithms, also referred to as evolutionary algorithms, are a technique that "acts upon a population of potential solutions, and employs the principles of struggle for survival to produce better and better approximations to the solution to a problem" (Khajeh, Payvandy and Derakshan 2016). Inspired by living organisms, generative algorithms are typically given a "fitness function" either by the developers (Inui 1996) or, in the case of interactive genetic algorithms (IGA) (Kim and Cho 2000; Hu, Ding, Zhang and Yan 2008; Mok et al. 2013; Khajeh et al. 2016), by iterative feedback from users (Kim and Cho 2000, 637). The users can be fashion professionals or end-users, and the feedback can either be actively given by the users or passively constitute the online platform data, such as in the case of Stitch Fix (Sibley et al. 2016). The fitness function can be relatively straightforward, as in the case of Synflux's Algorithmic Couture projects, which use machine learning and generative algorithms to achieve zero-waste pattern design of bespoke clothes based on 3D-scanned bodies (Pownall 2019; Synflux 2019).

Another case study in Publication IV, Matti Liimatainen, builds on the principles of genetic algorithms. However, instead of setting up the evolution of garment designs by choosing from many random computer-generated options, Liimatainen relies on genetic algorithm learning to create a single optimal option. To achieve this, Liimatainen translates his own tacit knowledge into numerical form and creates blanks that evolve into designs according to computer-generated briefs, comparing the process to an embryo that evolves into a body (Särmäkari and Vänskä 2022, 214). Liimatainen also draws from expert knowledge systems, early computational creativity (Gero 2000) and morphogenetic and generative design (Soddu and Colabella 1993; Maeda 2001; Agkathidis 2016). In this thesis, I use the term *generative clothing design* for such algorithmic fashion practices that focus on the garment shapes and structures rather than on the fashion and trend side of clothes that GANs provide.

Algorithmic fashion is intimately related to generative and parametric design, which has intrigued and been explored by architects and designers for decades.

The philosophy of generative algorithmic design is process-centricity: the focus is on creating processes rather than artefacts or products – recipes instead of meals (Tanska and Österlund 2014, 20). In generative design, the designer ceases to be a performer and becomes the conductor, "effectively orchestrating the decision-making process of the computer" (Gross et al. 2018, 3–4). Generative design is argued to emphasise "form-finding" instead of "form-making" and an iterative, cyclical and evolutionary feedback exchange between the designer and the design system (Agkathidis 2016, 8; Tedeschi 2014; Tanska and Österlund 2014, 12).

Several fashion designers and apparel companies that create 3D shapes unattainable to humans call parts of their algorithmic design processes generative design; they include Iris van Herpen and Under Armour (Lorenzi, Mele and Zecchetto 2021; Smelik 2020). In a project called Generator (2008–2009), Julia Valle-Noronha (2015) experimented with creating random and unexpected pattern shapes by developing an algorithm with set parameters that eliminate absurdity. The algorithm generates distorted patterns that designers can drape on a mannequin, using their human creativity (Valle-Noronha 2015). Just as in GAN-based or generative design, the designer's authorial and professional role is essential because the design happens through draping and making the garment. However, the computer is a creative companion that provides the shapes defining the further work of the designer-maker.

3. Methods

This qualitative research comprises four case studies. In a case study research strategy, one or several instances of a phenomenon are thoroughly investigated (Blatter 2012, 69). I study the digital fashion phenomenon and, within it, the phenomena of digital 3D fashion, algorithmic fashion and open-source fashion from the perspective of designer authorship and professionalism. The research material consists of primary and secondary data, collected between 2018–2021 following the ethical guidelines of The Finnish Advisory Board on Research Integrity (TENK). The reflexive thematic analysis method (Braun and Clarke 2006; 2019) was applied to honour the overall qualitative mindset of this research project with an active researcher role. My analysis process was abductive and iterative: concepts from the theoretical framework *and* empirical data simultaneously guided the coding and generation of themes. The data were analysed for each publication according to the research questions and scope of the articles. The publication plan and the focus of the articles evolved along the way through conversations with my supervisor, progress in data collection and analysis, and the writing processes. It was important for the publications to constitute a coherent whole that would present the arguments of this thesis through relevant evidence and from the perspectives of the proposed phenomena.

3.1 Qualitative multiple-case study research

Qualitative research and the case study strategy are suitable for studying complex, contemporary phenomena because these approaches allow zooming into particular instances (Yin 2018). These instances can be individuals, groups or communities in a certain situation, or represent a certain phenomenon (Stake 1995). Predominant in early social science, case study research was and still is seen as an ideal approach to consistently obtain and generate rich, in-depth and contextual qualitative evidence in complex real-life settings (Yin 2018; Blatter 2012; Eisenhardt and Graebner 2007; Stake 1995). Case study researchers advocate case-centred strategies, including thick description and process tracing, rather than the variable-centred approaches that dominate quantitative research (Blatter 2012, 68). The diversity of methods and research material within case study research enables triangulation of the research data, and multiple-case study research allows cross-case synthesis (Yin 2018, 194–199). While single cases are chosen because they are "unusually revelatory, extreme exemplars, or opportunities for unusual research access," multiple-case studies

arguably offer a more robust ground for a variety of empirical evidence (Eisenhardt and Grabner 2007, 27).

This research is both deductive *and* inductive, i.e. abductive (Yin 2018, 197; Timmermans and Tavory 2012). At times it was more data-driven, building theoretical propositions inductively from the empirical data, and at times more theory-driven, starting from theoretical propositions found in the literature. The role of theory is essential as a lens through which data and literature are viewed – as it often is in qualitative research, with or without the researcher's knowledge (Collins and Stockton 2018). My research stems from a premise that fashion designership is socially constructed, and my view is partial and situated (Haraway 1988). Qualitative research in general relies on the researcher's intersubjective interpretation, creativity, situatedness and experience (Denzin and Lincoln 2005, 26). The researcher appears as a bricoleur, quilt maker and editor, setting the stage and editing the material (ibid., 4–5). I aimed to describe, explore, understand and unfold the new fashion design processes in an existing fashion system, not to explain them. The execution of case study research can be somewhat flexible, changing with uncontrollable real-life circumstances, which the researcher has to integrate with data collection needs (Yin 2018, 98). The qualitative case study strategy entails the researcher's immersion into and interpretation of the complex phenomena. Therefore, the researcher should be transparent about their values, background, research process and overall personal standing point (Yin 2018; Eisenhardt and Graebner 2007; Stake 1995).

The quality of a case study relies not only on providing detailed evidence but also on using empirical evidence to make an argument within a scholarly discourse and theoretical framework (Blatter 2012). One of the challenges is striking a balance between case stories and theory. When studying fashion designers' work, case study research resembles the work of an art historian who focuses on a particular artist and their work by collecting as rich a range of data as possible. In such a setting, "[…] research becomes more like a humanities project involving close one-to-one relationships with a small number of players" (McRobbie 2016b, 946). However, instead of focusing on the auteurs or biographies, case study research investigates the phenomena and their context.

Obtaining physical access to cases was challenging, yet important. Conducting research in situ allowed me to embrace the agency of the social and technological environments where the designers work (McRobbie 2016b, 942; Latour 2000).

I was lucky to gain access to several small-scale companies and studied them in their physical environments, located in Europe: Finland (S-A, Minuju), Sweden (Atacac) and the Netherlands (The Fabricant). When I approached the cases via email to ask whether I could visit their studios to observe and interview them, I emphasised my background in fashion design. I was an "insider" who cares about the field of fashion and its future, can speak the same professional language, understands their situated knowledge and does not need explanation of the basics of fashion design. Furthermore, when the researcher comes from

the same field, the designer interviewee might not feel necessary to position themselves as an auteur in relation to the researcher (cf. McRobbie 2016b, 940).

Nevertheless, a connection with a prestigious university might be appealing to designers (ibid. 941). I also used my social relations (cf. Moon 2016). For example, when I was a teaching assistant, I helped host Atacac's designer Rickard Lindqvist for a talk at a seminar at Aalto University. I personally knew Matti Liimatainen (S-A) from my earlier fashion design studies, while with Minuju's designer I shared a similar education and a common former employer. I heard about The Fabricant during fieldwork at Atacac, where they regarded The Fabricant as the closest reference point, despite their very different practice. I contacted them without any social connections. After the first email, it turned out that the founder and CEO, Kerry Murphy, had Finnish origins. This might have been one of the reasons that Murphy, despite managing a flood of emails due to international media attention, responded to my email and let me in. I also contacted companies and designers that declined to be studied. Some were too busy or did not want to talk about their projects, while others (bigger companies) regarded their technological experimentations too nascent.

I did not need official approval from an institutional review board, as I studied non-vulnerable companies and experts.[24] The research participants did not prefer anonymity for two reasons: the community of designers and companies is small. Everyone knows the persons behind such distinctive practices as those I studied, and designers actually want to be credited for their innovative practices. Nowadays, designers openly and publicly share their work, and it makes little sense to anonymise research on their practices (McRobbie 2016b, 941). However, intimate personal data and the research participants' references to other people were anonymised as these people were not the research participants and thus had not consented to have their data included. All the participants in this study familiarised themselves with the letter of informed consent (see Appendix 3) before my visit and signed two copies of the document, which I co-signed. One copy stayed with the participant and one with the researcher.

3.2 Research material

The primary data were collected ethnographically through semi-structured interviews (all cases) and on-site field observation (Atacac, The Fabricant, S-A). Additionally, I collected material from web pages, social media posts, streaming, talks and other documents generated by the cases. The secondary data constitutes media publications and literature written on the cases. I gathered all the possible information, documents and secondary data about the case studies before fieldwork to ensure that I could ask relevant questions and not waste the

[24] Even though the data were collected mainly from human subjects, the subjects are regarded as experts, which was taken into account in the interview questions and observation focus points. Such experts are not part of a vulnerable population and therefore, according to TENK guidelines, this type of research does not require a review and statement from the Ethical Committee.

participants' time with questions they had already answered in other channels. After the fieldwork, I followed their work through media, social channels, talks and occasional personal conversations (see Table 4).

I chose ethnography because it is the most suitable method to "immerse oneself in a specific cultural context, participating in and observing routine practices within the field in an attempt to understand the experiences and perspectives of those studied" (Jenss 2016, 62). Developed by anthropologists, ethnography as a qualitative interview- and observation-based research method is one of the key approaches in fashion studies because it allows the researcher to concentrate on particular sites, locations and practices, and on their experience of work in the creative sector (Jenss 2016; Moon 2016; Kawamura 2011; McRobbie 2016b, 934). Though I had a different social position as an academic researcher, I was an "insider" because of my professional background. In this sense, this research did not entail the problem of classic ethnography that tends to "other" the site. However, I wanted to emphasise that I was not carrying out design myself; I am not their competitor but rather a researcher who wants to understand their practices.

During observation, I took field notes rigorously by hand in a notebook. Sometimes I also sat behind my computer and took notes directly on the computer. I tried to write as much as possible to remember every small detail and personal reflection. After each day of observation, the notes were imported into a Word file and reports were compiled, including all the notes and thoughts. Professional experiences as a designer were inevitably embedded in my fieldnotes, consciously and unconsciously (cf. Moon 2016, 71). I took as many photos as I could. Photos are the scenery and décor that provide a context to the research object (Rantala 2007, 149).

The time that I spent in the studios was limited for two reasons. First, staying more than a few days did not provide any further insight, as the teams' work happens predominantly on screens and even a brief observation period gave an experience of data saturation (Flick 2014). Most of the approached instances were quite justifiably wondering how I could observe them if they mostly sat at their screens. In this sense, their work differs from traditional fashion designers, who work with physical artefacts and who can be studied according to the art world ritual of the "studio visit" (McRobbie 2016b, 943). This aspect in itself points to the nature of digitally infused designers' work in contrast with more traditional fashion practices (cf. Vangkilde 2017; Moon 2016; Ræbild 2015; Skov 2002). The experience of the sufficiency of a short observation period might have been different if I had carried out participant observation, i.e. working in the company as an intern or a designer. The companies were small and their activities so technologically specialised that there would not have been space for me as a participant, not even as an intern for errands (cf. Moon 2016).

Second, the amount of time I spent in the companies was the time that they made available and I respected that. For such small companies, with busy schedules, allowing someone to occupy their time and intrude on their working space and social reality (Flick 2014, 160; Moon 2016, 70–71), even for two or three days, is a significant allowance.

Led by the situation, I conducted the interviews mainly in English, some in Finnish (S-A, Minuju), and one short interview in Swedish (Atacac). In semi-structured interviews the wording is flexible and questions are open-ended, adjusted to the situation and the interviewee (Kawamura 2011, 73). Sometimes the interview was more of a conversation, aimed at feeling as relaxed as possible. Interviews fluctuated between semi-structured and unstructured, depending on the interviewees' actions and my impression of the interviewees. In case study research, the stream of questions should be fluid rather than rigid (Yin 2018, 118).

I noted the same as Ræbild (2015): sometimes it is difficult for designers to verbalise their thoughts and describe their work. Therefore, the best strategy was to follow what they were doing and ask questions that occurred in this context. I created a list of questions under focus themes that were divided according to the interests of this research: the professional background, expertise and value structure of their occupation; the content of their work and the motivation behind their practice; collaboration with other professionals and non-professionals; the role of and relationship with technology; the relationship with the fashion industry and other fields (see Appendix 2). The themes evolved and new questions emerged organically during and after the interviews. It was vital for me to keep the key themes and the focus layers of this study (see Table 3 and Appendix 1) during the fieldwork at the back of my mind so that the interview would feel like a conversation and observation would be focused.

Table 3. Focus layers.

Image (How do they want to be seen?)	**Content of the work** (What do they actually do?)
Collaborative (How do they interact? Who does what?)	**Space and tools** (Physical and digital environment)

Interviews are an efficient way to collect rich empirical data. However, it might be biased when image-conscious participants are involved, and therefore interviewing different actors within the cases, observation and triangulation with other sources provide more multifaceted evidence (Moon 2016; Eisenhardt and Graebner 2007; Flick 2014). In two cases (Atacac and The Fabricant), where the companies operated as teams, I interviewed all the team members during their workdays. They were not isolated from their everyday activities because the activities and the technologies they were using in their work were also a tool for discussion.

Real-time and retrospective cases were combined in this case study research. Three of the cases (S-A, The Fabricant, Atacac) were real-time cases, and one case (Minuju) was retrospective (not operating at that moment). I conducted the latter interview at the former designer and co-founder's home office. All the interviews were audio-recorded. I recorded a pilot interview (the first field

interview) using an iPhone 6s, and the rest with the Zoom H-4 recorder. I noticed that the iPhone was less disturbing for the participants, probably because everyone is accustomed to the presence of smartphones. The Zoom H-4 is big and slightly intimidating; however, it is a high-quality professional recorder. I chose to use it as it captures the sound also when located further from the speaking person. Furthermore, using this recorder allowed me to use a smartphone to take pictures of the participants' activities during the interviews. Later, I transcribed all the recordings, which was simultaneously the first analysis step (see Table 4).

Additionally, the research material included any available written, spoken and visual data produced by the cases, such as publications, plans, webpage content, blogs, talks and social media posts. I treat social media and blog posts, website content and public talks as primary data because it is generated by the designers and their teams. For example, The Fabricant actively shares their processes and is continually present in media. Netnography (Kozinets, Dolbec and Earley 2014) was used to observe The Fabricant's design processes and conversations on the streaming service Twitch.

Netnography combines the internet and ethnography, equally studying cultural phenomena in their local contexts and naturally occurring behaviours and using the researcher as an instrument (ibid. 263). In the social and online media age, designers talk about their work rather extensively and willingly, blurring the boundaries between primary and secondary data (McRobbie 2016b, 938–939). Designers tend to give their precious and very limited time to fashion media and social media channels rather than researchers because it is their way of building a brand image and promoting collections (ibid. 940). The secondary data of this research comprises media publications and online interviews on the cases and around the phenomena they represent. Additionally, academic publications were used simultaneously as literature and as research material for the analysis of "digital", "algorithmic" and/or "open-source" fashion, as very little has been written about such fashion practices in humanities, social studies or design research. As the identified phenomena are at the core of the case studies, I also contextualise the particular cases with literature on the phenomena in question.

Table 4. The methods and research materials of this study.

CASE	DATA GATHERING METHODS	PRIMARY DATA	SECONDARY DATA	RESEARCH PERIOD & LOCATION
1 Matti Liimatainen	Semi-structured and unstructured interviews Observation	Transcripts Fieldnotes Photos --- Lectures Videos Website Research plan Design pitch	Media interviews and articles	2018–2020
2 The Fabricant	Semi-structured and unstructured interviews Observation Netnography	Transcripts Fieldnotes Photos --- Talks YouTube videos Website, blog Social media Streaming sessions	Media interviews and articles Blog posts Research paper	2019–2021
3 Atacac	Semi-structured and unstructured interviews Observation Netnography	Transcripts Fieldnotes Photos --- Talks YouTube videos Website PhD thesis by the co-founder Social media Report by the intern	Media interviews and articles Blog posts	2018–2020
4 Minuju	Semi-structured interview	Transcript --- YouTube videos Website MA thesis by the co-founder	Media interviews Blog posts	2018–2019

3.3 Reflexive thematic analysis

In their highly cited article on thematic analysis, Virginia Braun and Victoria Clarke (2006) propose six systematic steps of thematic analysis: (1) familiarising yourself with your data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; (6) producing the report. In 2019, the authors revised the 2006 article and added the term "reflexive" to highlight that they do not encourage treating these steps as a rigid structure or procedural recipe (Braun and Clarke 2019, 589). Instead, it should be an adventure while coding and developing themes. The idea of thematic analysis has roots in critical qualitative research, where the researcher's rigorous reflexivity and creative subjectivity underlie the epistemological assumptions (ibid., 591). The analysis phase is a creative process and craftsmanship that require the researcher to have erudition and a refined sensitivity towards the data (Syrjäläinen, Eronen and Värri 2008, 8). The ultimate goal of the patchwork of qualitative analysis is to increase human understanding and provide new knowledge about the area under scrutiny.

Braun and Clarke (2019, 591) argue against any attempts to cure the researcher's subjectivity through the reliability of coding, as they find qualitative research "creative, reflexive and subjective, with researcher subjectivity understood as a resource [...] rather than a potential threat to knowledge production." Echoing Haraway's (1988) concept of situated knowledges, they stress that meaning-making in qualitative research is always context-bound, positioned and situated. The analysis is a thoughtful result of deep immersion into the data. The themes should be generated actively by the researcher rather than passively emerge from the data. The method is also theoretically flexible as it can serve both constructionist and essentialist framing, an inductive and/or deductive orientation; however, the researcher must transparently articulate the assumptions, their "theoretical knowingness" and how they enacted thematic analysis (Braun and Clarke 2019, 591–292).

First, I had to transcribe the verbal data into written form. This time-consuming activity is an important way of familiarising oneself with qualitative data within interpretative methodologies (Braun and Clarke 2006, 87–88). Rather than being a mechanical act, the transcription process helps the researcher create meanings (Lapadat and Lindsay 1999). Therefore, I transcribed all the interviews and audio materials myself. I used a machine learning and natural language processing-based software called Sonix.ai to assist with some English transcripts and to save time. The software had little training in Finnish, and the automated transcripts turned out absurd. Even the English ones had to be heavily edited. The thematic analysis does not require as detailed transcripts as, for example, conversation, discourse or narrative analysis (Braun and Clarke 2006, 88).

The transcripts must, however, be rigorous and include all the needed information – whether verbal or non-verbal (coughs, laughs etc.) (ibid.). The

transcription style should suit the purposes of the analysis (Lapadat and Lindsay 1999). The transcripts were verbatim and included the text and the non-verbal communication but did not include information about items such as the duration of pauses in speech. I combined digital and analogue coding. I used Atlas.ti software to assist in digital coding and printed the transcripts for manual coding. I wrote codes on the paper when conducting analogue coding. I then chose the most relevant and frequent codes, wrote them on colour-coded sticky notes and divided them into thematic groups on a wall. The groups moved and changed throughout the analysis process. Roughly they were divided into five sections that had social and practical dimensions: relationship with and opposition to the established fashion world; flexible networks and community legitimisation; tools and technology as affordances and non-human companions; new workflows, processes, skills and practices; and embodied knowledge in a virtual space. From these groups, I further developed the themes from the perspective of each article and its research question.

3.4 Ethical considerations

The study entails human subjects, companies, a professional community and professional ethics. Therefore, I had to think carefully about ethical issues already when writing the research plan. I outlined that the project follows the ethical policy of The Finnish Advisory Board on Research Integrity (TENK) guidelines and ensures that the highest standards of ethics and responsible conduct of research are met. The research project concerns many stakeholders who have invested their time and resources in the project: the research subjects, the universities[25] where I have been affiliated, my supervisor and advisor, the entities that funded this research, and the whole academic and fashion design community. Therefore, I was tasked with generating new, valuable, honest, transparent, socially sound and meaningful research. The research participants were fully informed about the background and goals of the research, and of archiving, reporting and presenting the material, and were asked for written permission to do so in a letter of informed consent (see Appendix 3). All informants were provided confidentiality and anonymity and given a chance to withdraw from the project at any time. The most significant ethical challenges lie in balancing research integrity and confidential respect for cases. I was responsible for not revealing company secrets and placing the informants under social or economic threat.

My personal experiences and opinions on fashion and clothing design affect my judgement and the partial knowledge that I produce. My professional background helped me to communicate with designers, ask relevant questions and understand the answers. Knowing the conventional fashion design processes saved me from wasting the informants' time by talking about professional basics. Furthermore, I saved their time by collecting all available data on them before fieldwork, and by choosing suitable research methods; I am

[25] Aalto University School of Arts, Design and Architecture, Department of Design, and The New School, Parsons School of Design.

well aware that busy fashion designers are not very keen on participating in events such as workshops, which would require them to arrange time off work.

Lastly, the data is archived in the Finnish Social Science Data Archive, where it is available for other researchers on request to avoid bothering the informants again. I ensured the possibilities for subsequent use of the data by carefully documenting the data collection methods and contents of the dataset and by complementing the transcribed text files with basic information about the interviews and the field reports (metadata). I created a Data Management Plan (DMP) on the Finnish platform DMPTuuli (https://www.dmptuuli.fi) when I was applying for grants from the Finnish Cultural Foundation in 2018, and modified the DMP in 2020 when I re-applied for the grant.

Three of the four articles that comprise this thesis are published with open access to reach larger audiences and to follow the publication policy of Aalto University. I have asked all the publishers for permission to include their publications in this doctoral thesis.

3.5 Writing process

I started writing the first article (Publication I, Särmäkari 2020) in 2018 after giving a presentation at a conference in the field of aesthetics on how different dimensions of authorship – a central topic in aesthetics and art theory – are appearing in contemporary fashion practices. The organisers of the conference invited me to submit a book chapter (6,000 words) for a yearbook of the International Association of Aesthetics (IAA), which later changed into their edited academic book (*Aesthetics in Dialogue: Applying Philosophy of Art in a Global World,* edited by Zoltán Somhegyi and Max Ryynänen). I wrote the first version of the article in 2018 when I had only started collecting primary empirical data, while mapping and choosing cases. After a review and revisions, the chapter was eventually published in the book in 2020. The book's publisher, Peter Lang, is classified as an academic publisher with a scientific impact factor. With this chapter, written in the form of an article, my goal was to conceptualise fashion designers' authorship in relation to their profession and set the stage for further investigation that would focus on case studies.

The next article (Publication II, Särmäkari and Vänskä 2020) was co-written with my supervisor Annamari Vänskä in 2019 and submitted as a full paper (5,000 words) to one of the most important international conferences in the field of design research, organised biannually by the Design Research Society (DRS). We submitted to DRS because the scientific impact factor of their proceedings allows the publications to be included in article-based doctoral theses. The second article focused on the empirical and ethnographic research that I had conducted by the autumn of 2019 on three companies: Matti Liimatainen/S-A, Minuju and Atacac. These three companies were practising what we framed in the article as open-source fashion: fashion design practices that apply the elements of an open-source philosophy (categorised in a table, see Table 5 or Publication II, Särmäkari and Vänskä 2020, 2420) in their design approaches. I had already studied this phenomenon as part of the digitising

world in my MA thesis in 2013, and it was a logical continuation of previous research, focusing on real-life case studies.

The most significant publications of this doctoral thesis are the final two, published in two key academic journals in the field of fashion studies and fashion design research, *Fashion Theory* and the *International Journal of Fashion Design, Technology and Education*. I started writing the third article (Publication III, Särmäkari 2021a) during the spring of 2020, after conducting fieldwork at Atacac and The Fabricant. I was fervently following their further steps alongside the public conversation on digital fashion, which intensified during the global lockdowns in 2020. I also conducted an extensive online survey at the beginning of the year, receiving responses from 42 digital fashion designers around the globe, out of the 207 I had contacted through social media and an online digital fashion community. During the writing process, my supervisor helped me see (once again) that there was too much research material for one article and that it would be better to focus on case studies. Therefore, I decided to leave the material from the survey for post-doctoral research. The cases of Atacac and The Fabricant – both discursive leaders and active vanguards – were a rigorous way to frame the phenomenon of "digital 3D fashion" in relation to the academic and professional discussion on the digitalisation of fashion design, existing and evolving technologies (fashion 4.0), and questions of transforming designership. I reviewed all the literature that I could find on digital 3D design and virtual fashion culture, including only the most relevant in the article with a limited word count (10,000 words). I eventually submitted the manuscript to *Fashion Theory*, and after a long peer-review process and minor revisions, the article was accepted and published in 2021.

I started writing the final article (Publication IV, Särmäkari and Vänskä 2022) with my supervisor Annamari Vänskä after I had submitted the third article at the end of 2020. The goal was to write a final article on the third phenomenon I was studying – AI fashion design, which I later conceptualised as algorithmic fashion design. I chose the word "algorithmic" because not all fashion design that uses computer generation for creative and product development purposes uses what is considered as AI, and AI is, in fact, a vague term whose meaning depends on how close computer science has managed to come to the human brain. The writing process was rather long because the literature on AI fashion design and generative design is miscellaneous and, at times, very hard to read because most of it is published in the field of computer sciences. In a way, the literature simultaneously constituted research material, because it was analysed to understand and frame the phenomenon of algorithmic fashion design in fashion research language, from the perspective of the fashion design profession.

We connected the literature analysis to two case studies, Matti Liimatainen/S-A and The Fabricant, which had already been investigated in the previous articles (Publications II and III). They both used generative computer algorithms in their work in very different ways and represented posthuman fashion. At the beginning of writing, there were more cases that I had

interviewed and studied. Two of them came from an academic background and utilised algorithms in their patternmaking practices. One represented procedural fashion in computer-generated virtual worlds. We did not want to give too much attention to academic case studies, whereas procedural fashion better fits my future plans to investigate the gamification of fashion. We decided to drop them from the article for the same reason as earlier: it was better to focus on the prolific research material from the two cases that were different enough to be compared to each other and reflected against the main two algorithmic fashion design approaches detected through the literature analysis (generative clothing design and AI-aided fashion sketching). Our initial plan was to offer the article to the design research journal *Design Studies*. However, after sending an abstract to the editor, asking whether it would fit the scope of that journal, and being declined, we noticed that the *International Journal of Fashion Design, Technology and Education* announced a call for articles for a special issue on digital fashion. We decided to submit the article to this issue, condensed it to the instructed 6,000 words and modified the manuscript according to the journal's scope. After the peer-review and major revisions, the article was accepted and published online in October 2021. The last phase of this article-based doctoral thesis was writing this introductory section and tying together the articles.

4. Findings and outcomes

I proposed the concept of the cyborg (Haraway 1985) to understand the professional and authorial figure of the designer in contemporary technological environments. Based on empirical research on current digital fashion phenomena and four case studies, I argue that the new (sub)field of digital fashion contributes to the *(re-)professionalisation of fashion designers*. At this transitional moment, the digital fashion field provides novel employment and financial possibilities, entry to the field of technology and space for intellectualisation of fashion, which can be considered the current strategies of professionalisation and a subversive technique of newcomers who struggle for leadership and discursive power in the field (cf. Bourdieu 1993a; Rocamora 2016). With this power, their goal is not only to construct their subfield but also to change the ideals of the dominant fashion world. Fashion 4.0 practices are changing the ideals of fashion design from the autonomous designer to a community player who embraces an open-source design philosophy and adjusts their skills according to projects, collaborators and a co-creative audience.

The fleshiness and intimacy of fashion design transpire in algorithmic and digital fashion practices, in which designers use digital technologies as design companions, ledgers of their tacit knowledge, and sites and materials of creation. Fashion design has always been more technical, collaborative, embodied, messy and ambiguous than the auteur ideal and figure of fashion designers have suggested. Digital fashion culture has not emerged in a void: the biographies of technologies reflect the cultural realities and vice versa, and the performativity of fashion always existed in both the physical and fictional worlds. The fashion designer 4.0 is characterised by fluidity between and enmeshment with digital technologies, human networks and physical realities, other disciplines and non-professionals. This is simultaneously a reduced and an expanded role for a fashion designer: reduced in terms of possibility to focus on a very specific craft within the fashion industry, eliminating, for instance, physical production; and expanded in terms of spaces, networks, skills, products and even professional and industrial fields (see Figure 5).

The cyborg designer lies in between the fashion world and digital culture; between the physical and virtual worlds; intimate tacit knowledge and public, "objective", quantified knowledge; fixed and open-ended works. The designer also lies in between an instrumental value of conducting fashion to make a living by fulfilling people's needs and desires to wear functional and/or performative clothes, and "fashion for fashion's sake" – the intrinsic value of fashion created just for pleasure and for culture. Likewise, the value of novel digital tools and

companions might be highly instrumental in production efficiency and provide an experience of making things well as a craftsperson (cf. Sennett 2009). Ontologically, fashion design in the context of Industry 4.0 practices is re-professionalised and increasingly decentralised. Re-professionalisation refers to a *new professional jurisdiction* (Abbott 1988) rather than de-professionalisation (cf. Kawamura 2012).

Decentralisation refers to the organisational, production-related and authorial practices and the novel professional ideals rather than a contemporary reality of the fashion world. New fields and activities create new struggles and hierarchies (Bourdieu 1993a; von Busch 2012; 2016; Rocamora 2016, 247). Digital designers' hierarchies are defined by their technical skills (both digital and analogue garment construction), intellectual abilities and imagination, and, most importantly, the social capital acquired through communities.

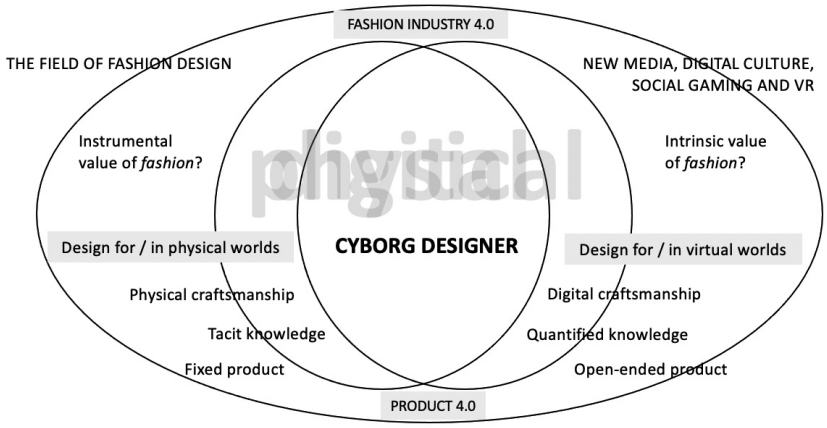

Figure 5. The cyborg designer or fashion 4.0 designer. Design: Natalia Särmäkari.

The above arguments and my research findings are presented in the outcomes of this doctoral thesis: the four peer-reviewed publications (I–IV) mentioned throughout this compilation part.[26] Publication I, "From Worth to Algorithms: The Role and Dimensions of Authorship in the Field(s) of Fashion Design," is a conceptual investigation of fashion designers' authorship in relation to their profession and contemporary digital practices. Publication II, "Open-Source Philosophy in Fashion Design: Contesting Authorship Conventions and Professionalism", delves into open-source philosophy as a design approach that

[26] The findings were also presented in the *Intimacy* exhibition at Design Museum Helsinki (8 October 2021–13 March 2022), in a book on intimacy, embodied knowledge and digitalisation in contemporary Finnish fashion design (Vänskä, Hokka and Särmäkari 2022), and in an academic book chapter (Särmäkari 2021b). The exhibition and the book are outcomes of a Finnish research consortium, *IDA – Intimacy in Data-Driven Culture*, and the project *Intimacy, Creative Work and Design*. The project is funded by the Strategic Research Council at the Academy of Finland.

contests the professional ideals and conventions of fashion design, analysing this phenomenon through literature and three empirical case studies. Publication III, "Digital 3D Fashion Designers: Cases of Atacac and The Fabricant", looks closely at two case studies that represent the rise of digital(-only) fashion and how they liquify the boundaries of fashion designership. Publication IV, "'Just Hit a Button!' – Fashion 4.0 Designers as Cyborgs, Experimenting and Designing with Generative Algorithms", explores algorithmic fashion design as another, more-than-human dimension of authorship and proposes to look at a contemporary fashion designer through the concept of the cyborg. The following four sections summarise the content of the articles and provide answers to the research questions.

4.1 Publication / RQ I: Contextual author-function – authorisation and deauthorisation

In the first publication of this article-based thesis, I wanted to understand the concept of authorship, how it has been discussed in art theory, how it is related to the profession of fashion design, and how some fashion practices are implicitly or explicitly reconfiguring authorship. The incentive for starting this doctoral research and writing this peer-reviewed book chapter was the contradiction that I have experienced as a fashion designer and professional in the field: I felt that our ideals seldom correspond to the reality of work and are sometimes even harmful to the designers' self-respect and overall well-being. The "artist myth" is strong and forces designers to overwork, compromise their financial circumstances and even give up family life, depending on their class, gender and social position (McRobbie 1998; 2016a).

In this conceptual and theoretical article, published as a book chapter in the field of aesthetics, I examine the concept of authorship in fashion design from a historical, aesthetic and sociological perspective in three parts. First, I introduce the roots of the notion of authorship that we might consider "traditional" – the Modern and Romantic notion (Woodmansee 1994; Bennett 2005; Burke 2008). I also unfold the roots of the fashion design profession, its relation to the emergence of the concept of art and artist in the 18th century and to the phenomenon of "artification", whereby activities that are not legitimised as fine arts can be ascribed the qualities and values of Art (Naukkarinen 2012; Shapiro and Heinich 2012; Crane 2012; 2019). From Bourdieu's field theory perspective, artification could be seen as a professionalisation strategy that creates hierarchies and stratification in the conventional fashion design field. Second, I shake up the value conventions of the fashion field by pointing to the collective nature of design work and to fashion's normalised copying culture, which has been a part of the practice since the times of Worth. I introduce different examples and phenomena in the contemporary field of fashion where the practices are intentionally de-artified and/or authorship is challenged in various ways, from cross-disciplinary collaboration and an open-source approach to anonymity and use of artificial intelligence. Third, I suggest how

contemporary authorship dimensions could be discussed, approached and understood.

Vasari arguably started the process of separating art from crafts during the Renaissance by writing artist biographies, which eventually led to art institutions and a Modern concept of fine arts (Kristeller 1951, 514). This concept is the *point of reference* in the processes of artification, by which non-art tries to come as close as possible to what we understand as art to add value to its practice (Naukkarinen 2012). In line with Crane (2019) and, indirectly, Bourdieu (1993a; 1993b), I regard fashion design as one such activity, even though I take no stance on whether fashion is "real" art or not. Artification and the figure of a unique, disinterested artist-author are the critical elements of professionalisation and value structure of the field of fashion design, be it haute couture, the "conceptual fashion school" (McRobbie 1998), or an invisible commercial designer who resents surrendering their artistic integrity. Coupled with efficient business strategies, artification enabled an authority shift from clients to designers, who employed "social closure" to exclude craftspersons and manufacturers and to attain the scarce resources, privilege and legitimisation for particular professional jurisdiction (Bourdieu 1993b; Bourdieu and Delsaut 1975; Abbott 1988). The intensity of artification determines the designer's position both *within the fashion field* and *among other fields*.

The designer's author-function (Foucault 1998 [1969]) depends on the market level, cultural location, institutional system, and a particular historical moment – a discourse by which it is created. This "functional principle" is used as a constraining figure to keep the proliferation of meaning under control (ibid. 221–222) and particular persons *responsible* for the content. Fashion as a field has always been a paradox of the author-function (or has represented a plurality of author-functions?), since copying culture has long been at the core of the practices, and the ability to protect copyright is somewhat limited (Raustiala and Sprigman 2006), while at the same time copying is socially condemned. Furthermore, the fashion field was arguably *de-artified* when couture turned into commercial luxury fashion, losing its craft and glow and old-fashioned elitism (Crane 2012; 2019; Lipovetsky 1994).[27] It is also characteristic of designers to build on previous designs, fashions, garment archetypes and cultural fabric. Therefore, fashion design is always a self-referential, intertextual, polyphonic and fluid palimpsest. In the network society (Castells 2010), digital culture and human-machine assemblages, the author-function is not only multiplied but also becomes a hyperconnected (Cheok 2016) mycelium of creative agency between humans and non-humans, professionals and non-professionals.

I present several examples whose practices construct the pluriverse of author-function, intentionally or unintentionally contest the Modern author with open-source mentality, having the starting point in contemporary technologies. These technologies bring design and manufacturing, as well as manufacturing and

[27] The craft and glow have come back into digital fashion practices; see e.g. "thought couture" by The Fabricant and "algorithmic couture" by Synflux. Both glorify craft and customisation instead of art and artist authority.

consumers, closer together, breaking the initial separation between art and crafts and the ideal of individual originality. Atacac leaves their products open for modification, whereas, at Minuju and mass-customisation businesses, designers design the fixed amount of ingredients that fit the brand identity, the digital co-design journey and the (inter)action space for *active* non-professional participation *before* garments are produced on demand. Self-Assembly invites *active* participation *after* the garment modules are designed and laser-cut. Self-Assembly is also an example of automation and collaboration between humans and computers. The function of algorithms and AI is often to *augment* the human creatively or structurally – either the designer or other professionals and non-professionals. In bigger contexts, algorithms analyse vast amounts of data and generate designs based on consumer data, meaning they participate rather *passively* in the design activities. In data-driven generative hybrid design, the designers' role is to curate and monitor aesthetic quality based on their tacit knowledge. Fashion design is fundamentally social. Therefore, initially, the human players of the field must decide who or what is the author. The creative subjects are *authorised*, performing a specific author-function in a particular sociocultural context and exclusive professional jurisdiction system.

The system and hierarchies of fashion are not stable: there are always newcomers who use revolutionary strategies to subvert the power structure and devaluate the capital of the established players (Bourdieu 1993b, 133; Rocamora 2016). Such newcomers might come from within the field (e.g. young designers) or from other fields, including technology (AI developers) and consumers themselves (e.g. influencers). I propose that, similarly to other creative practices, whether built on individual authority or teamwork, fashion design is often under *authorisation*, where the Modern notion of authorship is imposed, back-formed and retrojected (Nagy 1996, 92; Bennett 2005, 64). This means that in the practices where authorship is closer to collective than singular, the values of a Romantic author are imposed to give value to the practice. Even machines are *authorised* in AI fashion discourse, despite the lack of actual creative intentions, ambitions and complex professional expertise (see e.g. Jain 2019 and the case of an AI designer winning a fashion competition). In "open-source" activities that *deauthorise* the work, they turn the emphasis to the question of authorship and the hierarchies of the fashion system. The act of deauthorisation could in itself be seen as a strategy to redefine the field capital. Considering the paradoxical or hybrid quality of fashion design authorship, where authoritative and collective practices coexist, I propose to take a "both/and" rather than an "either/or" approach (Kaiser 2012). A designer pursues originality and is simultaneously a socio-cultural, situated subject with embodied knowledge. Therefore, the interaction between the hierarchical and the flat, and the presence and absence of the author, is what makes a fashion designer's authorship. Especially today, in the highly political fashion environment, the responsibility and intentions of the authors have far from disappeared. The fragmented culture and unfashionable state of authorialism might even brighten the spotlight upon the "constraining figure" (Foucault 1998 [1969], 221–222).

Moreover, authorships possess internal hierarchies: the "founders of discursivity" (ibid.), who influenced the fundamentals of how people think, are what Margaret Boden (1998) calls "transformational creativity"; something more original than "combinational" or "exploratory" creativity. Boden argues that the latter two are achievable for AI, whereas transformational creativity requires the social and embodied nuances that humans incorporate. In fashion design, similar hierarchies prevail, for example, in the form of leadership creativity and adaptive creativity. The former is transformational and leads the way, whereas the latter adopts the trends and creates within the novel directions proposed by the leaders (Ruppert-Stroescu and Hawley 2014). Based on these creativity typologies, I suggest that AI can only be an adaptive "fashion designer". Even though a computer generates designs, often based on data collected from many other people (Foucault's "anonymity of murmur"?), a human develops the algorithms or curates the outcome. Automation provides the designer with more autonomy and authorship by handling the non-creative tasks designers usually carry out, but keep quiet about them (cf. McRobbie 1998, 38, 124). Instead of the de-professionalisation of fashion designers, which has been suspected by the field and by scholars (e.g. Kawamura 2018, 116–117), professionalisation is turning in many directions; one is the need for Romantic "blackboxification" (inexplicable and hidden nature) of creativity and of human abilities like ethical and aesthetic judgement, incoherence, temporal sensitivity, fleshy knowledge and the ability to be a "founder of discursivity".

The main argument in Publication I was that regardless of the approach, the processes of authorisation and deauthorisation that fashion design undergoes are two sides of the same coin, revealing the situatedness of the author-function and pointing to the embodied cultural capital (Bourdieu 1986, 244–245) of designers.

4.2 Publication / RQ II: Digitalisation and open-source philosophy in fashion design

Publication II investigates the open-source fashion approach as a design philosophy and a phenomenon in today's digitalised and data-driven culture. Open-source fashion provides an alternative to the concept of authorship of fashion designers. These tendencies of the post-industrial network society and the "social turn" (Bishop 2006) are manifested in three case studies presented in the article: Atacac, Minuju and Self-Assembly (Matti Liimatainen). The article asks whether, how, why and to what end fashion designers contest the authorial and professional conventions of their field and what is the role of technology in such questioning. The article also conceptualises and contextualises the phenomenon of open-source fashion.

Open-source fashion shares the same philosophical roots as open design and maker culture. However, we approach "openness" (Mustonen 2013) more broadly, consisting of elements drawn from the open-source software movement, whose proponents believe in sharing as the path to personal liberation, flat hierarchies and unleashed collective creativity. "Openness" has

long been trendy, but unlike the often anti-capitalist "open design" (Bakırlıoğlu and Kohtala 2019), open-source fashion is also identifiable within the capitalist system. Open-source fashion challenges the traditional fashion designer figure deriving from industrialisation and the Romantic notion of authorship (see section 2.2.2). Open-source fashion exposes and decodes the myth of the fashion designer and aims at a more decentralised structure, defying the hierarchical and secretive conventions of the field, turning the "cathedral" into a "bazaar" (von Busch 2008; Raymond 1999). As a result of external and internal disturbance of the professional system (Abbott 1988), open-source fashion can be seen as the newcomers' attempt to shake up the field's status quo by using revolutionary strategies (cf. Becker 1982; Bourdieu 1993a; Rocamora 2016).

Several types of overlapping open-source fashion proponents were identified in the literature and existing practices: "academic advocates" tend to explore the role of designer, sustainability, new production methods and participatory as well as social design possibilities; "practitioners" typically hope to reduce negative social and environmental impacts through transparency, multidisciplinary community, co-design, and personalisation; "commercial agents" limit themselves to transparency and cost-effective mass-customisation; "amateurs" are individuals making or customising clothes; and "activists" combine design or hacking with activism. Our article focused on cases that simultaneously represent academic advocates, practitioners and commercial agents. The multiple-case study research aimed to determine the nature of a contemporary phenomenon through existing cases, while fathoming the complexity of each case. The cases were chosen based on their application of open-source elements, such as transparency, sharing of free, modifiable "blueprints," providing customisation services and on-demand production, and applying DIY and assembly practices. I conducted the data collection and analysis during 2018–2019, but have been following the work of Atacac and Self-Assembly and collecting further data also after writing and publishing the article.

Atacac is a small fashion company located in Gothenburg, Sweden. They developed an upside-down process and an alternative model for designing, presenting, selling and producing garments. Enabled and inspired by CLO3D software, Atacac creates and sells their garments mainly virtually, with minimum inventory, producing items on demand in their in-house mini-factory and pricing them according to flight-ticket logic (the garment costs the least when pre-ordered). Pioneering in digital 3D fashion, Atacac sells garments for both physical and virtual worlds. They believe that the accessible, even educational interface and visualisation possibilities of CLO3D are attracting an increasing number of amateurs. Atacac shares their patterns and 3D files on their online platform Sharewear, encouraging downloaders to make and modify the designs. Atacac emphasises transparency as their core strategy, referring to the typical elements of open-source fashion: keeping the code open-ended and distributed, working as a community, and considering their clients as participants. The company was founded by fashion designer and researcher

Rickard Lindqvist, who has developed a new patternmaking theory (kinetic garment construction), and software programmer Jimmy Herdberg, who has a long history in creating digital experiences for fashion companies.

Minuju was a retrospective case study, as the company no longer operates. Minuju was a Finnish children's wear company with a personalised product-service concept that implemented modular design through an online browser-based user interface. Minuju wanted to provide an ethical, sustainable, engaging and locally manufactured alternative to the traditional children's clothing supply. No ready-made sample collection or inventory was produced – only a stock of ready-cut pieces to be sewn together on order, in their studio. The designer's role expanded widely beyond clothing design, entailing coding, platform maintenance, visual and technical implementation, user research and module development. The designer's long experience in the children's clothing industry was essential in optimising the designs and meta-thinking about choices that the children and their children could make in the digital platform. However, the company was challenging to sustain financially. According to the designer, the product-service system could have been even simpler. Although families liked the idea of customising the clothes, they might have experienced "mass confusion" when confronted with too many choices (Piller et al. 2003).

Self-Assembly involves users in the garment construction phase. Founded by the Finnish fashion designer and researcher Matti Liimatainen, Self-Assembly is a clothing label that makes "ready-to-assemble garment construction kits", combining digital post-industrial and handmade pre-industrial production. The products have special seams based on a loop-and-hole system, enabled by algorithms developed by the designer. The garments can be assembled and reassembled into new designs without tools or any garment construction skills. The pieces are laser-cut at Self-Assembly's small Helsinki-based studio using a self-built open-source laser cutter. Liimatainen's research focuses on generative design development, applications of graph theory and automation of different phases that serve professionals and non-professionals alike. Provocatively questioning the idea of ownership and authorship in fashion, Liimatainen's ultimate goal is to create a fully automated garment designing and producing machine. Liimatainen's open-source philosophy extends to his work ethic. He plans to publish all his codes and algorithms openly on the Internet. He also actively builds on others' code. While he works alone, he wishes that his automated fashion design system could serve people with different backgrounds and skills. For example, a home sewer could ask the computer to generate both design and pattern.

A range of *open-source elements* was drawn from the literature on open-source philosophy and open design and used in the comparison between the empirical cases to answer the question of whether and how fashion designers' professionalism and authorship are contested. These open-source elements were *transparency, sharing free blueprints, customisation and co-design, on-demand production, DIY and self-assembly, in-house production and rapid prototyping,* and *togetherness*. We created a table (see Table 5) that categorises the elements and their relations to the case studies.

Table 5. Open-source elements of each case study (Särmäkari and Vänskä 2020, 12).

Case	Trans-parency	Sharing free blueprints	Customi-zation / co-design	On-demand produc-tion	DIY / Self-assem.	In-house produc-tion / Rapid prod.	Together-ness
S-A	X			X	X	X	
Minuju	X		X	X		X	X
Atacac	X	X	(X)	X	(X)	X	X
	sharing know-ledge & social resp.	*code distribution*	*authorship shared with non-professio-nals*	*Custo-mized produc-tion / two-way*	*user empow. / partici-pation*	*(digital) fabrication laboratory*	*horizon-tal team-work, commu-nity*

Three main themes were generated: (1) dialogue and open-ended products; (2) own fabrication laboratories; and (3) visionary craft-based designer expertise. All the cases rely on transparency, but Atacac also shares the code. All three cases combine digital and analogue design and production, as they primarily produce in-house and on demand. While Atacac uses kinetic pattern theory, Self-Assembly and Minuju rely on playful modularity. All the designers pointed out the importance of their solid professional backgrounds in making clothes. All three emphasise the appreciation of fashion and attire as culture, to which they want to contribute by inviting non-professionals. Minuju and Atacac developed an open-ended modular design, whereas Self-Assembly developed an open-ended garment. Internal and external synergies build the feeling of social togetherness in the cases of Atacac and Minuju, while Self-Assembly collaborates only with machines.

Drivers and limitations were further drawn from the empirical data to answer the questions of why and to what end fashion designers contest authorship and professionalism conventions. Four main themes were identified behind the "why" and "to what end".

1) Research-based alternatives to traditional fashion system with frustration towards the traditional fashion paradigm as a driver
2) The social turn and environmental values with professional ethics as a driver
3) Technological user experience, its enablers and limitations
4) Marginality and problems with openness

The empirical evidence supports the premises found in literature regarding the drivers behind open-source fashion, deriving from a frustration with the outdated ways of designing and making clothing. Their purpose was not to abandon professionalism or give up authorship but rather to propose strategies that elevate the conceptual and ethical standards of the field towards greater autonomy from the conventional fashion system and update the fashion field into the digital age. Facilitated by the tools and "grand narrative" of digital culture as external disturbances and the designers as internal disturbances (Abbott 1988), the old jurisdictions of fashion design were transformed. The

deauthorisation of fashion designers can be actually seen as an act of professionalisation. By authorising laypeople, open-source fashion design explicitly or implicitly represents the social turn (Bishop 2006), where underlying processes become more important than a professional aesthetic authority. Distributed authorship requires a shift in our cultural perception of the author-function that produces uncontrollable open-ended objects and action and interaction spaces.

The impetus for open-source fashion practices comes down to the accessibility, attractiveness and affordances (Norman 1999; Davis and Chouinard 2017) of today's digital technology. All the presented designers use their traditionally acquired skills and tacit knowledge. Ongoing development of automation and digital fashion tools hypothetically do not require as rigorous a traditional skillset, opening new possibilities for professional and amateur designers – and further research on digitalisation of fashion design. The cases experiment on the outskirts of the fashion system and find it crucial to stand behind their work, even at the expense of financial well-being (cf. McRobbie 1998). All the cases mainly receive their earnings from external clients and await further technological advances and cultural transformations.

Open-source fashion and other design approaches that aim at involving input from laypeople have been criticised for marginality, elitism (paradoxically!), risk of exploitation, unprofitability, lack of privacy, user exhaustion, degradation of quality, and a state of "post-democratic mob rule", familiar from social media platforms (e.g. von Busch 2012; 2016; de Mul 2011, 39; Vallor 2016; see Publication II, 2421). Despite its inclusive intentions, open-source fashion might create involvement where it is neither needed nor desired, and turn transparency into panopticism and robust self-regulation of designers (Vallor 2016, 188). Post-industrial fashion design is increasingly disembodied, dematerialised and deskilled as the acts of designing and making are performed at a distance through digital mediation (Atkinson 2017, 150). Furthermore, mediatisation weakened fashion designers' already almost nonexistent possibilities to protect their copyright, as the immediate dissemination of images enables even fiercer copying worldwide (Crane 2012, 107). Atkinson (2017, 148–151) argues that the realities of the post-industrial global fashion industry may differ significantly from Hunt's (2005) visions: the ideas on mass-customisation, DIY practices, maker culture and the end of mass-production are too optimistic. The open-source fashion approach better fits digital-only practices that do not invest in physical production.

4.3 Publication / RQ III: Digital 3D fashion design as a tool, affordance and novel fashion culture

Publication III frames the phenomenon of "digital fashion" which is seen as the next significant step in the fashion industry (e.g. Milne 2019; McDowell 2020; BoF and McKinsey 2021). In order to fill the gap of empirical research on digital fashion practices, I studied and analysed two pioneering, yet very different cases: Atacac and The Fabricant. Both build their practice around digital 3D

design tools, but have different workflows, end-products and approaches to the body. Atacac uses 3D software to create both physical and digital garments, based on Lindqvist's (2015) innovative patternmaking theory, enabling a novel business model. The Fabricant highlights that they provide fashion experiences that are never physical, that "waste nothing but data and exploit nothing but our imagination."[28] Another gap to be filled was the framing of digital fashion as a significant phenomenon and a novel fashion culture in the history of fashion, based on the media discourse and cases. The article treats digital(-only) fashion as an emerging layer of fashion practice, professionalism, authorship, materiality, business and culture.

The increasing use of advanced and fashion-specific 3D software in garment design processes is part of a broader fashion 4.0 digitalisation process that merges physical and digital (Bertola and Teunissen 2018; Noris et al. 2021; Nobile et al. 2021). Although digital fashion practices operate on the fringes of the industry and industrial manufacturing, they can be argued to entail the six design principles of Industry 4.0—interoperability, virtualisation, decentralisation, real-time capability, service orientation and modularity (Hermann et al. 2015; Bertola and Teunissen 2018; see Särmäkari 2021a, 20–23). How and why are Atacac and The Fabricant building their fashion design practice on digital 3D design? How are they redefining the fashion design culture and the fashion designer? Publication III proposes that digital fashion is an emerging subfield within the field of fashion design, differentiating itself from the professional conventions and building new strategies of professional jurisdiction and legitimation (Abbott 1988). For this journal article, I generated three themes from the research material: both digital fashion practices are driven by *sociotechnical affordances*[29] (Davis and Chouinard 2017) and *elevation of professional pride* through ethical, conceptual, artistic and skill differentiation, turning the designer into a digital artisan (cf. Aakko 2016) and a hyperconnected *fluid* professional – a *fashion designer 4.0*.

The *sociotechnical affordances* refer to the *technology, processes* and types of *end-products* that inspire and enable digital fashion practices. The 3D software that was chosen by both cases and nudged them to start their businesses was CLO3D. The software offers realistic and accessible digital visualisation and garment construction and simulates the behaviour of the garment on a human body in motion. The designer can use either CLO3D's immense fabric library or a CLO Fabric Kit to import existing physical fabrics into the program with all their material data. CLO3D merges design and patternmaking, as both happen simultaneously on the screen, in two windows: one with a 3D avatar and the other with a 2D pattern. The clothes also need to be "stitched" in the software; therefore, designers must know or learn the basics of garment construction. CLO3D builds on Marvellous Designer, a software program for game costume designing; thus, its roots are in digital imagery and

[28] https://www.thefabricant.com/

[29] According to Merriam-Webster dictionary, affordance stands for "the quality or property of an object that defines its possible uses or makes clear how it can or should be used." It is also an important concept in design.

modelling, rather than patternmaking. The company noticed that Marvellous Designer attracted many amateurs and fashion lovers. Therefore, they decided to develop software targeted at and developed by fashion designers. They added the file format DXF so that the software could incorporate garment pattern files and be compatible with other patternmaking software. The design process can start either from the pattern (Atacac) or from draping on an avatar (The Fabricant). Similarly, the human body and materiality are essential to both, but in different ways.

For Atacac's designer Rickard Lindqvist, the body is the starting point (cf. Ræbild 2015) and he finds physical prototyping and fittings still essential. The benefit of their micro-factory is that, just like in digital 3D design, they can acquire prototypes immediately, without waiting for parcels from abroad, and reduce production lead times to only three weeks. The designer of The Fabricant, Amber Jae Slooten, does not work with physical prototypes. However, she finds her tacit knowledge, garment construction skills and designerly ability to capture stories and feelings in garments and environments vital in digital workflows. The designer translates her embodied knowledge into digital form (c.f. Harris 2005, 24; Santos, Montagna and Neto 2020). The Fabricant's "production" phase means that the 3D models are developed further into animated fashion experiences with the help of various professionals, such as environment designers and 3D artists. Production may be very slow and very fast at the same time: the pace of fashion is turning from fast to instant (Rocamora 2013). Acceleration and immediacy are characteristics of the digital age that have also led to devaluation of material goods in the ever-shifting, interconnected, post-industrial, liquid, informational network society (Bell 1973; Bauman 2000; Castells 2000; Rocamora 2013; Bertola and Teunissen 2018; Santos et al. 2020).

Physical production is an integral part of Atacac's work and revenue. However, it was from them that I learned, during my studio visit, that the future of fashion is increasingly virtual. Virtual artefacts are by nature never finished and can always be built on. For Atacac, digital 3D models are representations of possible garments, whereas for The Fabricant, they are purely simulations. In addition to clothing simulations, they create shoes, avatars, environments, storyboards, concepts and animated videos. Focusing only on the "expression layer", as The Fabricant's designer calls it, is what we are already accustomed to in our "society of simulation" (Baudrillard 1994, 8), where images construct our identities. Fashion culture and practices have always existed as and been shaped by language and images (e.g. Barthes 1990 [1967]; Vänskä 2017b)[30], and fashion has been mediatised since the first fashion publication in the 17th century, affording a larger distribution of fashion imagery and texts describing fashions (Rocamora 2017, 509). One of the early proponents of digital fashion was a Russian-American fashion-tech consultant, Nataliya Makulova, who emphasised spirituality in relation to this emergent "new fashion paradigm",

[30] The first costume book was published in the late 16th century, but the first magazine paying attention to fashion was the French Le Mercure Galant, which wrote about fashion from 1672 (Tortora 2015, 62; Rocamora 2017, 509).

which goes beyond the material and exists in the virtual dimension where the boundaries between reality and illusion are blurred (see Nataliya.ai for LUKSO 2019). It has been a while since Wilson (2013 [1985], 157) noted that people purchase images rather than artefacts. In their studies on social games, other researchers have found that players treat even non-realistic digital apparel as commodities and social skins (Lehdonvirta, Wilska and Johson 2009; Watstein and Czarnecki 2010; Makryniotis 2018). Today, the dematerialisation of fashion goes beyond games and comes forth in virtual fashion shows, e-commerce, fashioned games, social media and other forms of digital fashion. E-commerce has rapidly grown, resulting in the normalisation of virtual garment representations. A blockchain-based digital fashion Web 3.0 marketplace, The Dematerialised, highlights its distance from the material world in its very name. The digital-only fashion house The Fabricant pronounces that they provide phygital experiences. As another early influencer, proponent, consultant and co-founder of The Dematerialised, Karinna Grant, pointed out, digital-only garments can be used in three ways: wearing them through AR applications on one's own body, dressing one's avatars as well as collecting and trading them as NFTs, in a similar way to digital art (Palumbo 2021). Blockchain technology authenticates digital clothes and makes them unique and unreachable to others (Hernandez et al. 2020). Such creation of scarcity and exclusivity has long been a part of fashion practices (Crane 2019). For example, Louis XIV restricted sales of many items in the 17th century to preserve their exclusivity (Kawamura 2004, 31).

Both cases criticise the professional exclusivity and protectionism of the fashion field. However, I argue that they pursue *elevation of professional pride* through ethical, artistic, intellectual and skill differentiation. Both Atacac and The Fabricant cases want to disrupt the status quo and provide alternatives to the conventional fashion world, which they find problematic and unsustainable. This research does not evaluate digital fashion's environmental or social responsibility, although the practitioners themselves consider sustainability and inclusivity as their key drivers. Firstly, use of 3D software minimises the use of material and logistic resources and enables a business model like Atacac's, where garments are sold before physical prototypes, samples or bulk are produced; only the desired quantities are made. Digital-only fashion eliminates physical production and uses only energy (which is a problem yet to be solved in the metaverse). Both cases believe that digital fashion spaces offer people possibilities to exhibit multiple selves and express their identities in ways richer than those enabled by the physical world. It is debatable whether this is actually happening (e.g. Atkinson 2017; Boler 2007).

Another aspect of inclusivity is the fashion design practice itself. Anyone with a laptop, internet connection and 3D software licence can (in theory) become a fashion designer without attending demanding, exclusive and often expensive fashion schools. 3D software is arguably accessible to laypeople and, as my informants pointed out, even teaches the user about garment construction. For example, an intern at Atacac who had a marketing background learned how to use CLO3D during work, and together with digital creative Jimmy Herdberg

they focus on developing the online visual experiences after the fashion designer has sent them the 3D garment file. It is debatable how many have this possibility and time to learn, but based on what I have noted on Instagram and CLO's online community, a vast number of designers come from non-Western countries. Many also have a background in something other than fashion design. Whether the facts behind ethical differentiation are solid or not, the most relevant issue from the viewpoint of this research is that the cases believe in and strive towards these aspirations. For example, both cases share their knowledge openly, even streaming their processes (The Fabricant), and eagerly advise up-and-coming digital fashion designers in social media communities. They emphasise the creation of sustainability for the work of professional designers, who in traditional settings are typically underpaid and overworked, if not unemployed (cf. McRobbie 2016a); for example, they talk a lot about their leisure activities and families, and consider long work hours as something to avoid.

Digital fashion culture builds upon optimistic views on fashion similar to those expounded by Elisabeth Wilson (2013 [1985], 246–47), who described fashion as "performance art" and as a way to scrutinise controversial modern culture, build identities, and liberate people through play and experimentation. Wilson's notion of fashion, together with Judith Butler's theory of performativity, has inspired many fashion scholars whose research focuses on socially marginalised groups such as LGBTQ+ (e.g. Geczy and Karaminas 2013; Vänskä 2014; 2017a; 2017b; 2018), racialised, ethnic or religious groups (e.g. Lewis 2013). Virtual worlds provide a medium for freedom in building performative selves and embodied experiences (e.g. Watstein and Czarnecki 2010). However, there is also a risk that the narrow and conservative representations of bodies, gender, sexuality and beauty ideals of both the real world and existing VR platforms will occupy the digital fashion space. Therefore, the key figures behind the ethos of digital fashion, such as The Fabricant and Cattytay (a digital designer, influencer, founder of DIGI-GXL and co-founder of The Institute of Digital Fashion), incorporate diversity, inclusivity and queering in their design practices and discourse, and encourage others to do so, too. These efforts aim to give the voices that are underrepresented and marginalised in the traditional fashion world and digital culture considerably more space in what is known as the metaverse (Showstudio 2021; Institute of Digital Fashion 2021).[31] Digital fashion plays an essential role as a new platform for garment representations, adding to the fashion imagery in fashion photography, illustrations, movies, entertainment and social media. Virtual dimensions and digitised fashion practices remediate, refashion and relationally coexist with traditional and material ones (Crewe 2013; 2017).

The politicisation of fashion is nothing new, but neither are *intellectualisation* and *conceptualisation*, which have long been legitimating and differentiating art fashion from mass-produced fashion (Van de Peer 2014; Clark 2012; Crane

[31] Manifesto by Institute of Digital Fashion https://indd.adobe.com/view/3991a46d-a089-4278-a11e-64f1710d7cc2. The goal of this manifesto is to pronounce the ethos of digital fashion culture.

2019; McRobbie 1998). Digital fashion re-artifies the field of fashion as it emphasises a conceptual approach, often detached from the garment as a commodity, and raises the value of fashion items as collectibles and even artefacts with intrinsic value (cf. Clark 2012; Crane 2012; Van de Peer 2014). Since The Fabricant introduced NFTs (non-fungible tokens) to the world of fashion in 2019, digital collectibles have significantly increased in popularity. NFTs are digital certificates of ownership and authenticity attributed to unique, irreplaceable digital assets that can be collected and traded (Hernandez et al. 2020). These tokens comprise a series of codes stored on a decentralised digital network – the blockchain. In 2021, The Fabricant collaborated with RTFKT Studios to create the gender-fluid RenaiXance digital-only collection, which sold out in the digital fashion store The Dematerialised in 11 minutes (Garg 2021). Soon after, RTFKT Studios raised USD 8 million in investments (Hore-Thorburn 2021) and was acquired by Nike (Lawler 2021). In this sense, digital fashion also differentiates itself from the traditional fashion world through economic possibilities and integration of the world of technology, thus merging two extremely gendered worlds. One is dominated by a female workforce and known for its (self-)exploitative practices (McRobbie 1998) and frivolous status, while the other has a predominantly male workforce and is known for high salaries, extreme profits and its "serious" position. Technology could be seen as one strategy for endowing "fashion girls" (ibid., 27–28) with the privileges and capital of the "boys' club" (Huopalainen 2016, 49).

Artification and *technologisation* are not the only forms of intellectualisation. Another is a research-minded approach. As the designer at The Fabricant said, the conceptual process is like a combination of a mood board and a research paper. Meanwhile, Atacac's goal is to develop intelligent ways of doing while "standing on the shoulders of giants" (see Publication III, Särmäkari 2021a, 19). Researching garment structures requires skills. A digital designer is also a *maker* who pursues *digital craftsmanship*. Therefore, technical *skills* (both digital 3D skills and garment-making skills) become a differentiation strategy. Hardware such as a digital knitting machine, 3D printers or laser cutters might bring designers closer to the production processes and non-designers closer to the design processes (Black 2019; Sun and Zhao 2018). Such post-industrial technology enables local, on-demand, small-scale production and experimentation (ibid.). The designer is no longer dependent on the heavy supply chain or on multiple other professionals or assistants to execute their products.

Additionally, organisational and communication skills become more crucial than ever when work happens in collaboration with fragmented and globally located teams, clients and freelancers. In the increasingly virtual and phygital fashion space and the synergetic, globally networked digital fashion community, designers' authorial, professional, material and bodily boundaries become *fluid*. This fluidisation transforms the traditional figure of fashion designers. Together with an open-source mindset, this fluidity and interactivity, I argue, are the key characteristic of the fashion designer 4.0. Designers co-evolve with technologies and communities. Legitimation of digital fashion designers is bestowed

predominantly by the large online communities rather than the established fashion world. However, lately, it has also happened in the more traditional manner.

Since Publication III on digital 3D fashion designers was published, the conversation has evolved and intensified. The Fabricant has developed their novel platform, The Fabricant Studio, which invites everyone to build on The Fabricant's designs, use the co-designed virtual outfits in games and other platforms, and even sell them as NFTs. With this project, The Fabricant took another step towards the metaverse – the extremely hyped virtual world that has raised the prospects of digital-only garments – or what digital fashion store Dress X calls "metalooks" (Palumbo 2021) – to an entirely new level. Until recently, the development of real-time virtual spaces has been dominated by the gaming, entertainment, medicine and military worlds, including the interactive virtual spaces Second Life (Linden Lab) and Entropia Universe (MindArk), both launched in 2003 (Watstein and Czarnecki 2010). Since then, platforms for commercial, social and educational purposes have appeared. Metaverse and Web 3.0 refer to the virtual space that contains data and is intimately connected to the real world, assets and bodies. Metaverse and Web 3.0 offer interoperability between any platforms to use the same assets (see The Fabricant Studio 2022). Users might have their "metafashion" wardrobes that are not attached to any specific game and engage with "metahumans" who do not exist in the real world (DressX 2022). Digital fashion and the metaverse have been often called a Wild West where anything can happen (e.g. Renwick 2019). Digital(-only) fashion has consolidated its position within the field of fashion and is now taken seriously. In March 2022, a legitimate Metaverse Fashion Week (MVFW) was organised by the metaverse platform Decentraland (McDowell 2022), involving everyone from fashion conglomerates to independent digital fashion brands.

I propose that the phenomenon of digital 3D fashion is what has been conceptualised as posthuman fashion (Vänskä 2018; Smelik 2021), merging human with non-human, materiality with virtuality and natural with artificial. In aesthetics of and the discourse on digital fashion, the human is regarded as a "digi-sapiens" (The Fabricant), a metahuman and a being that does not need to obey physical laws, while also emphasising the body and the fleshy experience of everything that is created. The posthuman figure also expands to the designer, who is positioned between the virtual and physical realms, merging their embodied knowledge with digital craftsmanship and creating a "world-changing fiction" (Haraway 1985). The following article – also relying on the research material on The Fabricant – delves more deeply into the subject of the fashion designer as cyborg.

4.4 Publication / RQ IV: Algorithmic fashion design: companion, "objectivity" and a posthuman conceptual approach

Publication IV investigates algorithmic fashion design approaches and asks how the automation of design processes and collaboration with machines affects

fashion designers' authorship and professional boundaries. In this journal article, we frame "algorithmic fashion design" as a "design approach that uses algorithms to process data and generate images, structures, digital models, and entire design processes in the context of fashion design" (Publication IV, Särmäkari and Vänskä 2022, 218). The article uses Donna Haraway's cyborg figure (1985) to understand how designers are intertwined with digital infrastructures. Two case studies – Helsinki-based Matti Liimatainen and Amsterdam-based The Fabricant – combine fashion designers' expertise, creativity and tacit knowledge with programming and/or computer-generated content in two very different ways, which in the article are explored and reflected against existing technical research on algorithmic fashion design practices. Liimatainen relies on *generative clothing development*, whereas The Fabricant relies on *AI-aided digital fashion sketching*. We argue that both approaches are characterised by *computerisation/hominisation, re-professionalisation* and *"cyborg designer 4.0"*. Hence, they develop more-than-human or posthuman fashion design methods. Algorithmic fashion design decentres the human fashion designer (cf. Vänskä 2018). Both Liimatainen and The Fabricant's designers are in a state of technogenesis (Hayles 2012) and technology configuration (Hyysalo 2010), where the designers co-evolve with technologies on cognitive and embodied levels and technologies become extensions of their bodies.

Algorithmic methods tackle two sides of designers' authorship and professionalism: creating *fashion* and developing *clothes*. The former requires market research, conceptual research and temporal sensitivity, whereas the latter focuses on the product, its pattern, functionality, innovativeness in terms of structure or details, user experience and desirability. The Fabricant is a digital-only fashion house that does not develop clothes. However, digital 3D models require as rigid a product development as physical clothes. The Fabricant used GANs (generative adversarial nets) (Goodfellow et al. 2014) for the fashion part of their *Deep Collection* (2018) process, to create sketches that could be compared to a designer's initial sketch in a sketchbook or a reference picture pinned on the designer's mood board. The Fabricant's creative director and head fashion designer, Amber Jae Slooten, then designed the 3D models by intuitively throwing and draping onto an avatar mannequin, with a certain feeling in mind and being steered by embodied experience (cf. Entwistle 2000b), and later developed the design details, story, environments and soundscape with their globally located network of freelance specialists with whom they collaborate.

The design process only starts with a sketch or picture, and actual expertise is needed to turn an idea into a product, collection and concept. The Fabricant used datasets of catwalk images as input to generate new machine-produced versions of the images as output, which is a typical way to approach *AI-aided digital fashion sketching* (cf. Luce 2019, 125; Kato et al. 2019; Sbai et al. 2018). If trends are pursued, images, text or videos may be crawled from social media, editorials, catwalks, reports and company databases. If designers want to find *inspiration* somewhere entirely outside of trends, they can use other digital

datasets as input. Although for The Fabricant, the primary role of the computer was inspiration from the computer-generated images and the concept of involving a non-human in the design process, the designer talked about the computer as if it were a co-designer, a companion. She felt that her role was to *curate* the computer's output, and she would have never come up with such a design without the algorithms and the bizarre collages of data from catwalks. The Fabricant performs an act of *hominisation* (cf. Vänskä 2018).

Matti Liimatainen is not interested in trends or human behaviour – the *fashions* of fashion design. Instead, Liimatainen unfolds the practice of *generative clothing design*, where the designer is teaching the machine to design physical clothes and develops algorithms that generate briefs, vector representations of garments, graphs, modules, garment patterns and seam structures, thus contributing to the area of AI for the garment design and production processes. Liimatainen builds the algorithmic systems himself, drawing from genetic algorithms and expert knowledge systems (Alcaide-Marzal et al. 2020; Guo et al. 2011). His ultimate goal is to develop a posthuman, entirely automated process that encompasses the whole production cycle from brief and design to interpretation, description, fabrication and use (see more details in Publication IV, 214). By "use", Liimatainen refers to the self-assembly part where the user assembles the garment in a manner akin to Lego construction. Liimatainen wrote an algorithm that automatically calculates the right structure for each loop-and-hole seam of each module. For Liimatainen, clothing design is compatible with algorithmic methods because clothes are constrained by the body, 2D materials, patterns and familiar clothing archetypes (Eckert and Stacey 2001; Kang et al. 2017). The parts of the system could eventually serve different professionals – for example a patternmaker who would like to generate a brief and design (cf. Kato et al. 2019).

For the interpreter phase, he has developed a GIM (garment information modelling) graph, inspired by a similar interoperable graph, BIM, used by teams in the building industry and architecture. The graph holds all the data of the garment based on seam rather than surface information. This digital twin can be read by any software and used interoperably in human-human, human-computer and computer-computer interaction (cf. Hermann et al. 2016). Therefore, a team of different professionals and algorithms can modify the same model, and companies can archive the models as a base for following collections. The graph is also Liimatainen's solution to the ambiguous communication between the teams and cultures, leaving no space for (false) interpretation. In such a setting of "objective" information flows, the designer, creative director or product manager might actually obtain more power.

In developing all phases of his system, Liimatainen teaches his own tacit knowledge to the computer[32], empathises with the computer and respects the computer's vitality (cf. Haraway 2016; Vänskä 2018; Smelik 2021), thinking

[32] Liimatainen developed a four-step version of this system for the *Intimacy* exhibition (8 October 2021–13 March 2022) at Design Museum Helsinki (curated by Annamari Vänskä, Jenni Hokka and Natalia Särmäkari), where he exhibited three Self-Assembly outfits and videos that show the four steps of the automated design process.

"How would a computer do this?" In this respect, he *computerises* himself while turning personal designership into algorithms and *authorises* the computer and the computerly ways of knowing (compared to the "designerly ways of knowing", Cross 1982). Liimatainen thinks that algorithmic design can augment human creativity and problem-solving capacity, create structures and shapes that are unattainable for humans and eliminate repetitive tasks. He provocatively envisions that his clothing design and production system could eliminate human-designer and human labour together with companies' profit-making ambitions because robots are not interested in fame or money. Having long and diverse international work experience in the high-end and high-street fashion industry, Liimatainen explicitly questions the myth of the designer. Therefore, he wants to give creative space to users with his open-ended modular products, to show that computers can design and make garments and thereby advance the knowledge on fashion designing. As Cross (2001, 49) pointed out, AI might perform alien intelligence, yet the research on AI does not aim to replace human designers but better to understand how humans think. AI and automation are developed to enhance and augment humans. The Fabricant also plans to automate as many activities as possible by closely analysing their workflows to speed up and optimise processes.

We argue that both cases *expand the bodily and social dimension of fashion designership*, making designers' professional figure a cyborg who is becoming, co-evolving and enmeshed with technologies, physical or/and virtual garments, code, data and human networks (cf. Haraway 1985; Hayles 2012; Vänskä 2018; see Publication IV, 217–218). Cyborg designership is evident in the cases' discourse. The Fabricant ascribes human qualities to the computer, hominises it, even though the computer can only learn the fleshy knowledge of humans or, in their own way, from data. Liimatainen, in contrast, computerises the human, absorbing the ontological principles of a machine while teaching the computer his fleshy knowledge. Either way, the cases treat computers as companions (Haraway 2003; 2016) and as prostheses, material, and media. They expand the social dimension of designership by *re-professionalising* the field, accentuating the complex, situated and embodied qualities of design, intellectualising processes, developing flexible technical and technological skillsets and interoperating with various networks of people and technologies.

Digital fashion brings new players to the field, such as computer scientists, mathematicians, designers with programming skills, and algorithms that can meet human needs and desires in their own ways. This way might contrast the humans' situated knowledges (Haraway 1988) and embodied designership with its data-driven, "objective" fashion epistemology, forming two different fashion systems. Automation of the production systems could, however, flatten hierarchies by enabling the survival of small fashion businesses, sparing them the need to hire human labour or, in the case of digital-only fashion, invest in machinery (cf. McRobbie 1998; 2016a). The professional jurisdiction (Abbott 1988) of algorithmic fashion design entails the aforesaid expanded bodily and social dimensions. Additionally, it encompasses generative design principles: designing the design processes instead of products (Agkathidis 2016) and

metathinking[33]. We propose the notion of *cyborg designer 4.0*, who is a phygital craftsperson, professionally co-evolving with computers in phygital spaces, moving between closed and open-ended design and using visual-numerical representations for communication (Publication IV, Särmäkari and Vänskä 2022, 218).

Based on the literature review and analysis presented in Publication IV, AI can be utilised in many ways, and intense research on this topic is providing an increasing number of new solutions every year. Until now, such technology has been more of an assistant and companion than an independent designer, the nature of whose work and professionalism includes a broader range of skills and qualities than an "AI designer" could provide. Professions involve a complex, multi-dimensional and embodied set of activities, skills and responsibilities, whereas AI can only replace certain tasks (Newman and Blanchard 2019, 12). As suggested in section 2.2.2, fashion design professionalism is based on situated and embodied knowledge, in which human designers' fleshy and social experiences from birth construct their relation to and tacit knowledge on clothes, fashion and design (Entwistle 2000a; Polanyi 1969; Ræbild 2015). For example, in a traditional design setting, fitting is a crucial phase of the design process, during which the garment design might change quite a lot. Fitting is one task that cannot be computerised – at least not if it is on a fleshy body (yet). Furthermore, fashion design is a social activity, and many decisions emerge in the process of negotiation. The computer cannot provide the social aspects of the work. Fashion design is also a socially legitimised practice where humans decide *whom* they want to wear. Furthermore, according to leaders of data-driven fashion businesses, data must be accompanied by human instinct and an element of surprise. Otherwise, the designs might become utterly dull and disengaging (Sibley et al. 2016; Sherman 2021).

[33] I use the term "metathinking" for activities where the processes of design are designed. I could have called them "metadesign", but this term is reserved for a particular type of social design framework, associated with design activism, where designers create environments for the owners of problems to act as designers (Fuad-Luke 2009, 151–152).

5. Discussion

The data of this thesis were mostly gathered between 2018 and 2020, some at the beginning of 2021. Since then, the digital fashion field has moved on quickly and continues to do so every day. Therefore, it is worth acknowledging that this thesis provides insights based on a particular moment in the history of digital fashion. In this sense, digital fashion is a challenging topic to study: knowledge immediately ages and new questions are continuously raised. Since 2019, when I conducted most of my ethnographic research in the studios, digital fashion has turned from a curiosity and a revolutionary newcomer into a more integral part of almost every established fashion company. This thesis is a contribution to the rapidly evolving field of digital fashion from the perspective of the fashion designer's profession.

5.1 Contribution of the thesis

The thesis provides new in-depth knowledge on the nature of authorship and professionalism of the "fashion designer 4.0". It contributes to research on the fashion designer's profession through case studies that contest the professional and authorial conventions by technological means, practising fashion 4.0. The project identifies three main phenomena:

1. Fashion 4.0 designers tend to apply an open-source philosophy to their work, in the form of co-creation with consumers, sharing their creations, flexibility of the products and general transparency. This challenges the authorial ideals that underlie the traditional figure of fashion designers. Although the nature of work itself has always been mostly collective, the *values* were traditionally based on auteurism and individualism. In contrast, digital fashion designers might have total control and unlimited space for creativity, enabled by their tools, yet the values of digital fashion culture highlight decentralised collectivism.

2. The most significant transformation happening in the fashion world is "digital fashion": virtual 3D design and prototyping in and for virtual environments. I treated digital fashion in my research as a new tool and companion that redefines designers' skills and processes, but also as a novel fashion design culture that emphasises digital craftsmanship, co-creation, posthuman ontologies, work sustainability, intellectualisation of fashion practices and proximity with the world of technology and gaming. As both the

tool-companion and a novel fashion culture, digital fashion expands the professional jurisdiction on embodied and social levels and pursues re-professionalisation of the fashion design field. Digital fashion designers are newcomers who use subversive strategies by dissolving the professional, authorial, material and bodily boundaries and technologising fashion design.

3. Interest in artificial intelligence and experimentation with algorithmic design challenges the authority of fashion designers and raises questions regarding human-machine interaction. Such questions have fascinated architects and design scholars for decades but in fashion design, these experimentations are relatively nascent. Algorithmic fashion design contrasts and reveals the embodied nature of fashion designers' work and the complexity of the socially constructed profession. Designers who experiment with algorithmic design deauthorise themselves and respect the computerly ways of knowing.

The main contribution of the thesis is the empirical investigation of fashion 4.0 cases (Publications II–IV) and theoretical analysis of fashion designer authorship (Publication I). While the aspects of fashion designers' authorship are implicitly mentioned in the sociology of fashion and explicitly studied in law, this research project aimed at providing a deeper understanding of the contemporary author-function of fashion professionals. This thesis looks at the alternative new roles, professionalism and authorship of fashion designers in the context of the late post-industrial network society and fashion industry 4.0. The processes and thinking of the cases in contemporary technological environments are reflected against the traditional setting and fashion thinking in each article.

The findings propose that *the field of fashion design is experiencing a paradigmatic turn in the professional identity* that no longer seeks legitimation through individual authorship but rather through online communities, digital craftsmanship, datafication and human-machine synergies (Publications III and IV). All case studies emphasise these values in the content designers have produced, their social media discussions and their media interviews. Furthermore, the thesis also adds a layer of technoscience and posthumanism to the sociology of professions. Moreover, the thesis participates and develops the discourse and the concept of *fashion 4.0* and *fashion design as a situated embodied practice*. It unfolds and portrays the figure(s) of the fashion designer 4.0.

Unlike many studies that analyse designerly professions, this study does not entail historical research on fashion designers' professionalisation. It also excludes the focus on a particular geographical location or society. Instead, the context is the globally dispersed technological environment in which fashion designers operate and of which they form a part. The sites are not particular countries or cities (cf. Chun 2018; McRobbie 1998; Kawamura 2004), but case studies that represent particular phenomena and specificities of contemporary developments in the fashion industry. The digital space is, this thesis argues, a

new site and an addition to the polycentric and polyarchic development of the fashion world (Skov 2011; Godart 2012; Gilbert 2006). The digital space incorporates certain ethics of digital culture that I call the "open-source philosophy of fashion design".

I approached the characteristics of the profession of fashion designer on a somewhat universal level. Despite major differences in national policies, funding possibilities, histories, schools, peripherality, social security systems and cultural specificities (e.g. Chun 2018; Smelik 2017; McRobbie 1998; Kawamura 2018), the professional myths and different hands-on work practices unite fashion designers around the globe. Today, fashion designers also tend to be educated and employed in more than one country or, if neither of these is true, they draw influences from both leading and peripheral fashion cities and their fashion cultures (McRobbie 2016b).

The study focused on the values and the modes of production (cf. Aakko 2016) of contemporary phenomena in fashion design practices through the lens of professional jurisdiction (Abbott 1988) and how this jurisdiction is potentially transformed by digitalisation (cf. Valtonen 2007). At the same time, I aimed to go further than Schön's experience-based knowledge and Polanyi's tacit knowledge and challenge the concept of professional and ontological boundaries (Gieryn 1983) that define the professional jurisdiction (Abbott 1988). To do so, I followed the posthuman or more-than-human approach of feminist technoscience (Haraway 1985; 1988; Hayles 1999; 2012; 2017), which I find relevant in understanding the contemporary situatedness and fluidity of fashion design authorship and profession.

5.2 Theoretical and practical implications

This thesis contributes to the study of the profession of the fashion designer and how digitalisation affects it. It provides theoretical investigation on contemporary authorships and empirical research on unique and vanguard digital fashion practices that represent the transitional moment in the fashion design profession. It contributes to the knowledge on the fashion design profession in fashion studies by studying this newcomer group that works in a digital space and constructs digital fashion discourse. The contribution to design research is explorative, as the thesis generates positioned, partial and situated knowledge (Haraway 1988) on digital designers' work, approaches, technologies and philosophies.

The main theoretical implications of this thesis are adding to the discussion on distributed authorship, contemporary fashion authorship and design professionalism. I have argued that authorisation and deauthorisation, computerisation and hominisation, datafied "objectivity" and situated "subjectivity", professionalisation and de-professionalisation, embodiment and dematerialisation, intellectualisation and craftisation, as well as slowness and immediacy, coexist in digital fashion design cultures. These cultures and practices strive to elevate professional pride and the survival of fashion culture in different forms, maintained by a plethora of professional and non-

professional networks. These theoretical conclusions were drawn from rich empirical knowledge gained from real-life settings.

Another theoretical contribution is the interlacing of posthumanism with authorship and professions studies by using the concept of the cyborg to describe the contemporary dimensions of fashion designers' professional jurisdiction and re-professionalisation. Furthermore, digital practices have pushed us to think more explicitly about materiality and bodies and to scrutinise how human designers design and think (cf. Cross 2001) and what an embodied human means in fashion (cf. Vänskä 2018). Digital and algorithmic fashion are not replacing physical clothes and human designers. In fact, they even encourage paying closer attention to the fleshiest, most precious, material, haptic and affective aspects of clothes and fashion design practice. The parallel virtual existence reminds us how things, both physical and virtual, are configurated through embodied interaction with them (cf. Hyysalo 2010), as Crewe (2017, 127) writes: "A laptop full of letters will never be as significant as a handful of the original objects, with the traces and memories of reading, holding, receiving, touching, feeling. Our relations to our things are sensory, bodily, evocative, and profound."

The practical implications of the thesis serve fashion businesses, young fashion designers and experienced fashion designers, navigating their way in the transforming fashion world. Despite "haute-tech" experimentations by some designers, the traditional fashion industry and high fashion have been rather technophobic (Lee 2005, 18). Technological lagging was also highlighted by the case studies – especially the one working with digital-only fashion: at the beginning of their practice, they found the fashion industry was highly sceptical and critical. Sandy Black (2019) argues that the dynamics within the fashion industry are changing and becoming liberated from time, place, actor and constellation constraints, and fashion enterprises should be redefined in the digital economy. The transition from the traditional wholesale-based fashion business model to a direct-to-consumer model is argued to hold a range of possibilities for fashion designers to implement digital technology and enhance their design practices – without, however, replacing the craft methodologies (Black 2019). Embedding digital into fashion designers' practices and finding their place in the digital economy requires collaboration with other professionals with a tech-start-up attitude. Replacing optimal physical operations (such as stores) with digital alternatives might save designers time and finances (ibid.). Black also argued that integration of digital technology should happen simultaneously in design and production processes, acknowledging that the development of new models is not possible without resources and sufficient investment.

Further, the thesis provides analyses of current practices that redefine fashion design in the digital economy. The in-depth treatment of the key fashion 4.0 phenomena through the case studies and proper contextualisation through a literature review will hopefully provide helpful insights and confidence to fashion practitioners when reflecting on their career paths. Likewise, these insights might serve fashion design education. Based on the findings of this

study, educators might discern which new skills should be integrated into fashion design curricula, which old skills should be cherished and how these skills interrelate. Fashion practitioners might find novel ways of building their businesses and enriching their professional palettes, increasing self-awareness, and having a more pragmatic perception of their field and its value structures. Lastly, fashion organisations and professional unions could draw from this study when outlining strategies, communicating with investors, ensuring fashion designers' professional jurisdiction, and working on various improvements in the field.

Digital fashion practices and, especially, the metaverse have raised many concerns. The term metaverse originates from dystopia[34] and indeed parallels are still drawn between them; Mark Zuckerberg's renaming of Facebook as Meta reminded people that the metaverse could become a single-corporation dictatorship. Although sustainability aspirations drive digital fashion designers, the metaverse is also (for now) anything but sustainable (e.g. Stephens 2022). Open-source philosophies have also been criticised for their neoliberal attitude and creating other types of dictatorships and oppression (von Busch 2016). Algorithmic practices have been scrutinised since it became evident that data, algorithms and people who create algorithms are often biased and oppressive (Akter et al. 2021). Data collection might turn into "dataveillance" and an exaggerated belief in data, i.e. dataism (van Dijck 2014), while algorithms are becoming the new gatekeepers in the field of fashion (Rocamora 2022). When technologies are developed and applied – including the ones for "metafashion" and AI designers – the question of what *could* be done always needs to be accompanied by the questions of what *should* be done and to what extent.

5.3 Reflections

Words are limiting and limited; therefore, it is only possible for me to express a fraction of what I have learned on the cases and phenomena. No matter how much I try to empathise with the cases, the writing up of the research often feels excessively simplifying. In the words of Dragos Simandan (2019, 141), developing Haraway's framework of situated knowledges:

> Only after information has been discarded can a situation become an event people can talk about. The total situation we find ourselves in at any given time is precisely one we cannot provide an account of: we can give an account of it only when it has 'collapsed' into an event through the discarding of information.

Something is always missing in textual communication, and writing must accommodate the academic standards. Parts of the vivid worlds were left out in being squeezed into publications with limited word counts. The thesis provides a positioned and situated analysis of contemporary phenomena and in-depth glimpses into particular practices in the field of fashion design, proposing a novel notion of fashion designership in a technologically transforming

[34] The novel *Snow Crash* (1992) by Neal Stephenson.

environment based on my interaction with cases and literature. As Haraway (1988) encouraged us to acknowledge, the researcher's perspective is and always should be partial and local, and instead of performing the "god trick", the researcher should preserve claims to objectivity through politically explicit situated knowledges (Haraway 1988, 578).

This thesis pursued rigour by reflecting as critically as possible on the phenomena and research material throughout the research journey. Careful documentation and transparent description of empirical data collection increases the reliability of the data and enables further research by others. Following the cases continuously and closely, and informally discussing with the designers when having the chance to do so gave me the certitude that I am not falsifying and misinterpreting their sayings and doings. To ensure that I do not distort the theoretical underpinnings that I rely on in this research, I discussed the research regularly with my supervisor and advisor and, as much as possible, with the larger academic community in seminars and conferences. The case study approach allowed me to collect a broad and diverse dataset that consisted of diverse primary and secondary data (see Chapter 3). In qualitative research, rigour and trustworthiness are best achieved through triangulation of the research material and data analysis (Golafshani 2003). The diversity and multiplicity of research material enabled data triangulation, whereas co-authoring articles, constantly presenting my research, getting feedback and later curating a research-related exhibition[35] and co-authoring a book on contemporary Finnish fashion design (Vänskä et al. 2022) triangulated my analysis to some extent. At every step of my research, I consciously reflected on my positioning and how it mirrors my approach, communication and interpretation.

Like any study, this one has its limitations. First, it is limited to three European geographical locations (Finland, Sweden and the Netherlands) and four cases. The fashion field operates on an international level, including people from different countries with different cultures and educational backgrounds; therefore, the cultural background of the research participants might affect the findings. I intentionally left out a focus on certain geographical locations and comparisons among Northern and Central European countries from the scope of this research, the main premise of which is the fragmented, globally distributed Industry 4.0. If this was another kind of study, focusing on cultural and societal differences for instance, a larger geographical scope could have provided evidence on various working cultures. If this study had been interested in the professional evolution of Finnish designers, the study could have focused on local practices and their historical context. However, local specificities and global differences would be another type of study.

This thesis provides particular moments in fashion history between 2018 and 2021 from the perspective of four cases. My personal professional background in fashion design both deepens and limits this research: on one hand, I have a tacit understanding of how fashion design and knowledge are generated; on the other, my interpretation draws from personal experience in the Western fashion

[35] *Intimacy* exhibition at Design Museum Helsinki (8 October 2021–13 March 2022).

system. I witness situations in particular moments from the perspective of a female designer who was trained in Finland at the beginning of the 2000s, and I choose to look at realised worlds in the pluriverse of possible worlds (Simandan 2019). It is hard to tell what was missed and what was remembered. The participants were also aware that they were observed by a researcher, which might have affected how openly they behaved and worked. However, such partiality is at the core of qualitative research on creative practices. As Bjørn Rasmussen (2014, 24) writes about research on arts:

> The researcher who, for the sake of objectivity, attempts to establish independence or neutrality towards the researched 'reality' will never succeed in understanding this reality. The reality is changed by interaction with or intervention in reality. Meaning or knowing is only possible or interesting when the person who wishes to understand the other realises that this encounter influences who the other is and how that person acts.

If I had been an employee or an intern in these companies and conducted a longitudinal study on their work, my data would probably have been even richer (cf. Vangkilde 2017; Moon 2016). However, such methodology would have limited the research to fewer cases, and their everyday processes and relations would have excessively dominated my focus. Moreover, working in such companies would have required special technological skills – the ones that I am investigating. Learning such skills is time-consuming, although I did learn the basics of CLO3D design to better understand such technologies and the designers who talk about them. Long-term participant observation would have entirely changed both my research design and focus and, beyond that, it would have been somewhat challenging to fit into the dynamics of the case companies.

The practices of these cases could be considered vanguard and relatively marginal. However, The Fabricant, for example, has become widely known in the fashion world as a significant game-changer. The cases are glimpses into possible future developments in the fashion design profession, and the evidence they provide is not generalisable – which is typical for qualitative research, the strength of which lies in the in-depth treatment of a small sample. However, the discourse around the cases and the phenomena they represent constructs the professional culture of other traditional and digital fashion practitioners and inspires newcomers. I identified similar characteristics in the discourse of the cases and other players in the digital fashion field that actively present at conferences, share their thoughts on social media and give interviews for the fashion media. The development of technology creates new challenges for the already unclear rule structures of designer authorships and professional ethics. The research topic concerns ethics that have been given only limited attention in this thesis. To my best knowledge, there are no general ethical guidelines for the professional field of fashion design. Even the legal discipline focusing on authorship issues in fashion (fashion law) is very young and continent-specific. However, focusing on ethics would have implied different research questions and epistemologies.

5.4 Conclusions and future directions

The thesis provides a perspective on particular digital fashion practices at the beginning of the transition into the digital space of fashion 4.0. Through four case studies and conceptualisation of the emerging phenomena of open-source fashion, digital fashion and algorithmic fashion, I have provided analysis on the re-professionalisation and re-authorisation of fashion designers and their transforming professional jurisdiction. Instead of pursuing the status of original artist, designers' professionalism comprises advanced technological skills and rediscovers the craft of garment-making. "Digital artisans" build a fashion culture that echoes the pre-industrial, pre-individualist and pre-authorship maker-figures. The figure of the fashion designer 4.0 is still legitimised by institutions, media and the fashion industry, but also increasingly so by an assemblage of users, online communities, data and algorithms. The complex spectrum of the professional jurisdiction of the fashion designer 4.0 merges embodied fashion knowledge with advanced digital skills, data literacy, flexibility, analytical readiness, metathinking, a conceptual approach and critical thinking. Communication skills and social interoperability are more important than ever, either for designers working alone with a global network or in teams of flexible and multidisciplinary professionals. The figure of fashion designer 4.0 is a cyborg, characterised by professional, authorial, corporal and material fluidity.

Moreover, the digitalisation of the fashion design profession is academically understudied and there are many areas to be investigated. Education and employment aspects are time-sensitive and highly important topics to be addressed as fashion companies are looking fiercely for metaverse and 3D-design talent, competing with Big Tech (Butler-Young 2022). Fashion schools have already taken steps toward updating education (e.g. Byrne 2021) and these transitions in curricula provide fertile ground for longitudinal ethnographic research and other forms of analysis. Educators, students and their future employers alike should be studied. According to the evidence of my study, digital fashion companies were still searching for their proof of concept, yet digital fashion design skills and understanding of the digital culture were already seen as an undoubted and well-paid career opportunity for individual designers seeking employment in bigger fashion, gaming or technology companies. In consequent studies, an analysis of the current job advertisements in comparison to the older ones, for example, could show what kinds of skills are currently sought.

The situations of the companies studied in this thesis have changed since the initial data collection. The Fabricant generated little profit in 2019, but is flourishing now and has significantly expanded their business, while Atacac has separated its fashion studio from its micro-factory in order to scale its activities.[36] Matti Liimatainen has chosen to focus on research and development

[36] In April 2022, The Fabricant raised USD 14 million in investments to build their metaverse wardrobe, see https://venturebeat.com/2022/04/07/fabricant-raises-14m-to-build-the-wardrobe-for-the-metaverse/ [accessed 24 May 2022]. Atacac's founder Rickard Lindqvist has separated the micro-factory from Atacac and founded a business called [a]industri together

of the automated system before (or even instead of) pursuing astronomical investments, and successfully applies his algorithmic tools to working for other companies. Minuju has never returned, but the reason for this is more complicated than the viability of the business model. Studying business models and the economic sustainability of digital fashion practices was also outside the scope of this thesis. Nevertheless, these aspects should be critically explored in future studies.

Another area that should be studied further is the fashion designers' professional role in the merging fashion and gaming world. The USD 176 billion gaming industry (forecast to reach USD 219 billion by 2024) has attracted big fashion companies such as Gucci, Louis Vuitton, Balenciaga and Ralph Lauren to collaborate and create virtual collections, fashion games and in-game skins (Milne 2019; BoF and McKinsey 2021, 57–58). How does the gamification of fashion and the fashionisation of games shape the creative culture, collaboration, data-driven practices or professional profiles of design teams, for example? Despite the hype around the fashion metaverse, there are many risks. At the moment, the heavy environmental impact of NFTs' energy use and problems with cybersecurity have to be solved (Bof and McKinsey 2021). Although production of digital garments is argued to have a 97% smaller carbon footprint than production of physical garments[37], the "use" and entire lifecycle of digital garments (especially NFTs) is yet to be compared with the use and lifecycle of physical ones.

The inventor and pioneer of AR, Louis Rosenberg (2021), also warns that the metaverse holds many unprecedented risks, including distortion of our perception of reality as the boundaries between physical and virtual dissolve. Despite the advantages of AR (e.g. strengthening work performance), it "[…] will make us even more dependent on the insidious layers of technology that mediate our lives and the powerbrokers that control those layers. This will leave us increasingly susceptible to manipulations and distortions by those who can afford to pull the strings" (Rosenberg 2021). If Big Tech companies, such as Meta (formerly Facebook), will dominate the metaverse, the current problems related to social media algorithms might be amplified. Furthermore, real-world problems might receive less attention as the AR experience will filter out unpleasantness for privileged people. The possible negative impact on everyday practices of the metaverse as it becomes more established – including in fashion practices – require closer critical assessment.

During my future postdoctoral research in the Finnish research consortium IDA – Intimacy in Data-Driven Culture[38] and on a project that focuses on

with Johanna Wirell to provide digital and physical garment production services on a larger scale, see https://aindustri.com/ about [accessed 24 May 2022].

[37] This study was conducted by Dress X, a company that sells digital-only clothing, and therefore it is not as neutral as studies conducted in academia. The findings are presented on Dress X's website: https://dressx.com/pages/sustainability-raw-data-references [accessed 12 January 2022]. However, we can agree that digital garments do not create inventory or use raw materials, transportation or underpaid manufacturing labour.

[38] IDA is funded by the Strategic Research Council at the Academy of Finland. The principal investigator of the project, wherein I now work as a doctoral researcher and will continue to work as a postdoctoral researcher, is Annamari Vänskä.

intimacy in creative work and design, I am planning to continue my research on digital fashion and dive in some of the directions suggested herein. Digitalisation and datafication of fashion design interweave with other cultural spheres and design fields.

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Appendix 1: Interview themes and questions

1) **Background, expertise and value structure of their occupation**

- What is your professional background, education, work experience?
- Why did you choose this profession? What was emphasised during the studies? What kinds of values were central?
- What kind of work or position is the most appreciated and valued among your peers? What is the ultimate goal of every fashion designer? Has this goal remained unchanged throughout your career?
- How would you define the expertise in your work? What knowledge or other skills are the most valuable in your work?

2) **The content of their work and the idea behind their practice**

- How did you come up with this idea and business model?
- What has been done and what is done now?
- What kinds of team members do you have? What is each team member's role in the company? What do they actually do? What do you actually do every day?
- What kinds of plans there are?

3) **Collaboration**

- Who do you collaborate with or work with every day?
- Does someone have impact on your design? Who? Why?
- What role do your customers play in your practices?

4) **The role of technology**

- What kind of technology is used and/or developed?
- Why did you choose the technologies that you are using now?
- How and for what purposes do you use the technologies?
- What kinds of technologies are you planning to use in the future? Why? How have you experiences using these technologies?

- What kind of technology have you used when you started your career and how do you experience the change of your work since then?

5) The relationship with the fashion industry and other fields

- What kinds of stakeholders/companies do you collaborate with?
- What do you think is expected of you within the fashion field and among the stakeholders you collaborate with? How about other fields? Do you work with fields other than fashion? Why?
- How has the traditional fashion industry reacted to your approach to practising fashion?

Appendix 2: Letter of informed consent

LETTER OF INFORMED CONSENT

Research participants are informed about the background and goals of the research, archiving, reporting and presenting the material, and asked for written permission to do so by drawing a letter of informed consent.

This is a research project on fashion designers' authorship and occupation, carried out by doctoral candidate Natalia Särmäkari for her doctoral dissertation at Aalto University School of Arts, Design and Architecture. The outcome of this research project will be published in academic peer-reviewed journals, conference proceedings and by Aalto University publisher Aalto ARTS Books. The interviewer (the investigator) ensures the interviewee reads this form carefully and has answered any questions the interviewee may have. Before the interview can start, the investigator and the interviewee should sign two copies of this form. The interviewee will be given one copy of the signed form.

Consent for Participation in Interview Research

I volunteer to participate in a research project conducted by doctoral candidate Natalia Särmäkari from Aalto University. I understand that the project is designed to gather information about the work and authorship of fashion designers. I will be one of the experts interviewed for this research.

1. My participation in this project is voluntary. I understand that I will not be paid for my participation. I may withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, it will remain confidential.

2. If I feel uncomfortable in any way during the interview session, I have the right to decline to answer any question or to end the interview. I have the right to ask the researcher to remove possibly sensitive or otherwise unwanted content from the transcript after my participation.

3. Participation involves being interviewed by the researcher from Aalto University. The interview will last approximately 60 minutes. Notes will be written during the interview. An audio recording of the interview will be made. If I do not wish to be recorded, I will not be able to participate in the study.

4. I understand that the research material will be systematically processed, backups will be created and data will be protected. The research material obtained through interviews and the audio recordings will be transcribed into text files will be archived at the Finnish Social Science Data Archive for future research and teaching purposes. The possibilities for subsequent use of the data will be ensured by carefully documenting the data collection methods as well as the contents of the dataset, and by complementing the transcribed text files with basic information about the interviews.

5. I understand that if I choose anonymity, the researcher will not identify me by name in any reports using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure. All information that allows identification of the anonymous informants will be removed from the archived text files. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions.

6. Access to raw notes or transcripts will be restricted. This precaution will prevent my individual comments from having any negative repercussions. If the gathered data of this research proves to be too sensitive, or I do not grant permission to archive the data, the interviews will be destroyed after the original research is completed.

7. I understand that this research study follows the ethical policy of The Finnish Advisory Board on Research Integrity (TENK)'s guidelines.

8. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

9. I have been given a copy of this consent form.

_____ My Signature

_____ My Printed Name

For further information, please contact:
Natalia Särmäkari, natalia.sarmakari@aalto.fi

_____ Date

_____ Signature of the Investigator

Appendix 3: Map of digital fashion designers and companies (20/45)

COMPANY/ DESIGNER	TECHNOLOGIES	CORE OPERATIONS	DESIGNER'S ROLE	PRODUCT	LOCATION
ATACAC	3D digital design Digital platforms	Open-source sharing On-demand production	Design, Pattern-making	Garments and digital-only garments	Sweden
THE FABRICANT	3D digital design Machine learning	Digital fashion house, digital couture, virtual fashion platform, open-source sharing	Designing digital-only garments, concepts and storyboards, collaboration w/ freelancer network	Digital-only garments, film and environment, avatars	The Netherlands
CARLINGS DIGITAL COLLECTION	3D digital design	Garments worn on a photo	Designing digital-only garments	Digital-only garments	Norway
IRIS VAN HERPEN	3D printing	Haute couture	Artist in collaboration with architect/3D specialist	Garments	The Netherlands
ADIDAS	3D digital design Digital customisation platform Algorithmic?	Digitised 3D design process, Customised sportswear/ shoes	Modular design	Sports garments, sneakers	Germany
Project MUZE, ZALANDO x GOOGLE + ZALANDO Research, generative design project	Machine learning, GAN	Experimental project	Curation, execution of physical garments	Mostly digital-only garments, a few physical	Germany
Stitch Fix	Algorithmic Online service	Recommendation, subscription	Data-driven design, curation	Garments	USA
Amazon Lab126	Algorithmic, machine learning, GAN	Mass-produced fashion, online retail	Data-driven design, "AI designer"	Garments	USA
Minuju	Online service platform	Mass-customisation	Modular design	Garments	Finland

Post-Couture Collective	Online platform, rapid digital manufacturing	Open-source On-demand Assembly by user	Modular design	Garments and accessories	The Netherlands [+ global network]
Self-Assembly	Algorithmic, rapid digital manufacturing	Open-source On-demand Assembly by user	Modular design	Garments, accessories, methods	Finland
Generator	Algorithmic	Experimentation, artistic research, Randomness, draping	Coll. with programmer and algorithms	Garments	Brazil / Finland
Ziwei Mo	Algorithmic 3D digital design	Hacker ethic Practice-based and constructive research	Developing algorithms, Garment design, patternmaking	Garments, design methods	China / Finland
Parsons School of Design, 3D digital fashion design course	3D digital design	Education	Design and patternmaking	Physical and virtual collections	USA
Superficial	3D digital design, 3D modelling historical garments	Conservation, archiving, providing experiences	Mirroring construction, capturing materiality, simulating dynamics	3D-models, animations	USA
Algorithmic couture	Generative design	Zero-waste design	Optimising patterns	Garment patterns	Japan
Myntra	Recommenda-tion system, machine learning	Mass-produced fashion, online retail	Data-driven design, “AI designer”	Garments	India
DIGI-GXL/ Institute of Digital Fashion	3D digital design, animation, AR/VR	Community building, artistic work, education, fighting old conservative fashion world and hierarchies, feminism, focus on womxn employment in tech	Designing digital-only garments, artwork, concepts and political activity, freelancer network	Digital-only garments, artwork	Global [founder(s) from UK]
Lifeforms / Dream Estate	Procedural fashion design	Worn in virtual world on “androids”	Generative design	Digital-only garments, avatars	USA
Tribute Brand	3D digital design	Worn on photos	Designing digital-only high-end	“Contactless and cyber fashion”	Croatia?

			fashion garments	digital-only garments	
Studio PMS	3D digital design, animation, AR/VR	Communicating fashion, fighting old conservative fashion world and hierarchies, feminism	Designing digital-only garments	Digital-only garments and environment 3D models of real garments	The Nether-lands

The field of fashion design is undergoing fast and fundamental flux, rendered by digitalisation. This doctoral thesis investigates how the profession of fashion designers is affected by current transformations in technological environments ensuing from "fashion 4.0". Contributing to fashion studies and design research, the theoretical framework of this qualitative research draws from authorship theorisation, the sociology of professions and posthumanism. The empirical multiple-case study research (2018–2021) focuses on four pioneering, technologically advanced fashion design practices, where the creation happens in virtual spaces and is shared with non-professionals, networks or machines. The case studies are The Fabricant, Atacac, Self-Assembly and Minuju. The article-based thesis consists of four publications and an introduction, providing new knowledge on the authorship and professionalism of a "fashion designer 4.0" operating in the digitalised society. It argues that the new (sub)field of digital fashion contributes to the re-professionalisation of fashion design through open-source philosophy, posthuman discourse, intellectualisation of fashion practice, novel employment possibilities and entry into the gaming and technology fields. Fashion 4.0 practices are changing the ideals of fashion design from the autonomous designer to a community player and metathinker who adjusts their skills according to projects, collaborators and co-creators. The fleshiness of fashion design transpires in digital fashion practices, wherein designers use digital technologies as design companions, ledgers of their tacit knowledge,

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